

THE DEGREE OF PREDICTABILITY
OF FOUR TYPES OF SENTENCES AS MEASURED BY THE
EYE-VOICE SPAN OF GRADUATE STUDENT READERS

By

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To my husband Frank and daughter Kristie

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TABLE OF CONTENTS

	<u>Page</u>
ACKNOWLEDGEMENTS	iv
LIST OF TABLES	vii
LIST OF FIGURES	viii
ABSTRACT	ix
 CHAPTER	
I INTRODUCTION	1
Statement of the Problem	1
Justification for the Study	2
Definition of Terms	3
Plan for the Study	5
The Sample	5
The Materials	5
Data Collection	8
Treatment of the Data	9
Hypothesis	11
Limitations	12
II REVIEW OF THE LITERATURE	13
The Deep Structure Model	13
The Chunk Model	18
Language Development and Reading	21
Levin and Kaplan's Model	21

CHAPTER		Page
II	EVS — The Measurement Tool	22
	EVS and the Unit of Decoding	25
	Related Research	26
	Summary	27
III	COLLECTION AND TREATMENT OF DATA	29
	The Sample	29
	The Instrument	30
	Collection of Data	34
	Treatment of Data	35
IV	ANALYSIS OF THE DATA	39
	Findings Related to the Assumptions	40
	Findings Related to the Hypothesis	40
	Findings Related to the Questions	44
V	SUMMARY CONCLUSIONS AND IMPLICATIONS	61
	Summary	61
	Conclusions	62
	Related to the Hypothesis	62
	Related to the Questions	63
	Recommendations	71
APPENDICES		
A	SENTENCE TYPES	78
B	PARAGRAPHS CONTAINING TARGET SENTENCES AND UNRELATED SENTENCES	83
C	SYMMETRY OF THE VARIANCE-COVARIANCE MATRIX	96
REFERENCES		98
BIOGRAPHY		103

LIST OF TABLES

TABLE		<u>Page</u>
1	Cell Means for the Randomized Block Factorial Design	42
2	Summary Table for the Randomized Block Factorial Design	43
3	Analysis of the Interaction of Critical Point by Type of Transformation	45
4	Difference of the T's	46
5	Analysis of the Interaction of Basic Versus Transformation by Critical Point	47
6	Difference of the C's	48
7	Analysis of the Interactions of Type of Transformation by Basic Versus Transformation	49

LIST OF FIGURES

FIGURE		<u>Page</u>
1	Schematic of the Randomized Block Factorial Design	10
2	Mean EVS by Critical Point for the Basic and the THERE Transformed Sentences	51
3	Mean EVS by Critical Point for Active and Passive Sentences	52
4	Mean EVS by Critical Point for the Basic and the WH-Question Transformed Sentences	53
5	Mean EVS by Critical Point for the Basic and the IT-Inversion Transformed Sentences	55
6	Mean EVS by Critical Point for Passive and the THERE Transformed Sentences	58

Abstract of Dissertation Presented to the
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Psycholinguists have offered at least three different language processing models to explain the strategies involved in the reading process. Two models, the deep structure model and the chunk model, offer diametrically opposite explanations. A third model, offered by Harry Levin and Eleanor Kaplan, suggests that readers use their knowledge of sentence predictability in attempting to decode and comprehend sentences.

This study focused on the degree of predictability of specific types of sentence transformations. Answers to the following questions were sought:

1. Is there a difference in the degree of predictability as measured by the eye-voice span between
 - a) a basic sentence and its THERE transformation
 - b) an active sentence and its passive transformation
 - c) a basic sentence and its WH-question transformation
 - d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?
2. Does the number of transformations within a sentence affect the degree of predictability?

3. Does the type of sentence transformation affect the degree of predictability?
4. Does the position in the sentence where the eye-voice span is measured affect the degree of predictability?

Sentences containing the four types of transformations tested were developed by the researcher. The eye-voice span was measured at pre-determined places in each of the sentences. The study sample consisted of 20 University of Florida Reading and English graduate students.

The data were analyzed using a randomized block factorial design with repeated measures. Results showed that there was a significant three-way interaction: type of transformation by basic versus transformation by critical point.

Further analysis indicated that there was a complex interrelationship among the three independent variables -- type of transformation, basic versus transformation and critical point -- on the eye-voice span measurement.

There was no evidence from the data to support any of the language processing models. The findings indicated that since no one variable by itself can explain the differences in the eye-voice span measurements, the explanations of language processing offered by the major models are too basic.

CHAPTER I

INTRODUCTION

Psycholinguists have attempted recently to explain the strategies involved in the reading process through the use of language processing models. Two major models, the deep structure model and the chunk model, offer diametrically opposite explanations of the operations that occur during language processing. A third model has been offered by Levin and Kaplan (Levin, Grossman, Kaplan, & Yang, 1972, p. 30). Sentence predictability is central to the model. These researchers have been concerned with determining the extent to which readers use their knowledge of the predictability within sentences in attempting to decode and comprehend the sentence. Studies have shown that eye-voice span can be used to investigate such questions.

This study focused on the degree of predictability of specific sentence types. Since eye-voice span was used as the tool for measurement, information about the amount of material which is picked up and processed by the reader in each sentence was examined.

Statement of the Problem

The purpose of this study was to determine which of four different sentence structures have greater degrees of predictability within sentences. Answers to the following questions were sought:

1. Is there a difference in the degree of predictability as measured by the eye-voice span between

- a) a basic sentence and its THERE transformation
 - b) an active sentence and its passive transformation
 - c) a basic sentence and its WH-question transformation
 - d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?
2. Does the number of transformations within a sentence affect the degree of predictability?
 3. Does the type of sentence transformation affect the degree of predictability?
 4. Does the position in the sentence where the eye-voice span is measured affect the degree of predictability?

Justification for the Study

Recent studies examining language processing have been conducted to determine whether a reader uses the knowledge of language regularities as an aid in processing a sentence. Levin, et al. (1972) and Clark (1965) have shown that some parts of sentences are more predictable than others. According to Levin, et al. (1972), "sequences of words in language are constrained by rules" (p. 30). The rules which set the constraints are called grammar. The reader creates expectations about the language based on the detection of the grammatical constraints in the language. "The exact pattern or distribution of constraints appears to depend on the grammatical structure of the sentence" (Levin, et al., 1972, p. 31). Levin and Kaplan (1968) have suggested that the reading process may involve "some internal decision-making mechanism, which utilizes its knowledge of linguistic structure to determine how the message shall be processed" (p. 258). Cromer (1970), after reviewing the results of his study, has proposed that one source of comprehension difficulty might be "attributed to the way some poor readers organize reading input" (p. 471).

This study investigated further the processing of language which takes place during reading. Specific sentence structures were used to determine the nature of the regularities and to determine whether there was any relationship between the degree of predictability and the type and number of transformations in each sentence.

The eye-voice span has been shown to be readily affected by the difficulty of the material (Anderson, 1937; Fairbanks, 1937; Levin & Cohn, 1968; Stone, 1941). With the control for word number and vocabulary, differences in eye-voice span would indicate differences in the difficulty of the material. Therefore, the number of words in each sentence and the vocabulary in each sentence used in this study were controlled. A longer eye-voice span measurement would indicate greater ease in decoding the sentence and greater predictability.

Definition of Terms

1. critical point - A pre-determined place in each experimental sentence where the eye-voice span (EVS) was systematically measured. When a subject reached a critical point in the sentence during his oral reading, the screen was blackened and an EVS measurement was taken.
2. intra-sentence constraint - The pattern of contingencies between sentence parts. The predictability of sentence parts.
3. eye-voice span - In reading aloud, the EVS is the number of correct consecutive words reported by the subject beyond the critical point in each sentence. "The distance, usually measured in words, that the eyes are ahead of the voice" (Gibson & Levin, 1975, p. 360).
4. deep structure - The ultimate underlying form of a sentence.
5. surface structure - The way we see and hear language. The acoustic or graphic level of an utterance.

6. transformational grammar - The set of rules that lead from the deep structure to the surface structure.
7. basic sentence - A sentence which is made up of a noun phrase and a verb phrase. A basic sentence does not contain transformations.
8. WH-question transformation - A question beginning with a WH-word. Examples of WH-words are who, what, where, when, and why. The following is an example of a WH-question transformation:

When will firemen have the equipment for their orientation?

The sentence upon which this transformation is based is

Firemen will have the equipment for their orientation tomorrow.

9. THERE-transformation - "Usually a string of words will not undergo the THERE transformation unless it contains a form of BE. The transformation moves the BE and the auxiliary element or elements preceding it to the beginning of the string, then adds 'there' before the auxiliary element(s) and the BE form" (Malmstrom & Weaver, 1973, p. 148). The following is an example of a "there" transformation:

There were men on the docks approaching the machinery.

The sentence upon which this transformation is based is

Men were on the docks approaching the machinery.

10. infinitive subject nominalization - Consists of "To" plus the base from a verb which is used in the subject position in a sentence. The following is an example of an infinitive subject nominalization:

To install alarms throughout the house is too expensive.

11. IT-inversion - A noun phrase used as the subject is moved to the end of a sentence and the element "it" is added in the subject position. The following is an example of an IT-inversion transformation:

It is too expensive to install alarms throughout the house.

Plan for the Study

The Sample

The study sample consisted of 20 University of Florida Reading and English graduate students. Two requirements in the selection of subjects were that they could read vocabulary limited to Mitzel's Functional Reading Word List for Adults, and that they could read sentences involving embedded transformations and transformations which expand the basic sentence. Poor readers might not have been capable of handling either the vocabulary or the sentences designed for the study; therefore, the selection of subjects was limited to able readers. Any subject who had difficulty reading the sample sentences orally was eliminated from the study. Eliminating subjects who had difficulty with the sentence tasks did not affect the study, since the study focused on the way able readers attacked each of the forty sentences.

Limiting the selection of subjects to Reading and English students was necessary to assure that there were minimal differences in the way subjects approached the reading task.

The Materials

Sentences were developed for use in the study. The vocabulary was limited to words from the Functional Reading Word List for Adults (Mitzel, 1966).

The sentence types developed by the researcher were limited to the following:

1. A basic sentence and its THERE transformation.
2. An active sentence and its passive transformation.
3. A basic sentence and its WH-word transformation.
4. A basic sentence and its IT-inversion transformation with an infinitive subject nominalization.

The sentence types were chosen for the following reasons:

1. Except for the active and passive sentences, all of the sentences involve a process in which the subject is moved from the beginning of the sentence to a position following the verb or modal.
2. The passive transformation and the THERE transformation involve one transformation each. The WH-question transformation involves two transformations, and the IT-inversion transformation with an infinitive subject nominalization involves three transformations.
3. The active and passive sentence types were used by Levin and Kaplan (1968) in their study. A comparison will be made between the results found in this study using new active and passive sentences and the results of the Levin and Kaplan study.

The eye-voice span was measured at predetermined places (critical points) in each of the sentences. In both the basic sentences and the transformed sentences, the first, second, and third critical points followed the first, second, and third words respectively in each sentence. The fourth and fifth critical points followed three-word phrases. The following are examples of the positions of the critical points in the basic and transformed sentences:

	1	2	3	4
Basic Sentence:	Exercise/is/difficult/in	the beginning/for	many	
	5			
	individuals/with	major health problems	from poor eating	habits.

	1	2	3	4
THERE Transformation:	There/were/witnesses/near	the accident/from		
	5			
	the collision/of	the two trailer trucks	on the nearby	bridge.

Passive Transformation: 1 2 3 4
The/helpless/animal/was being cornered/by the
5
dogs/in an open field near the winter cabin.

WH-question Transformation: 1 2 3 4
When/will/newsmen/know the truth/about
5
the proceedings/against the five men from the new company.

IT-inversion Transformation: 1 2 3 4
It/is/profitable/to outline chapters/
5
in a book/to organize your study of unfamiliar subject matter.

The second critical point followed a verb or modal in all of the sentences except the active and passive sentences. The second critical point followed an adjective in the active and passive sentences.

One sentence was used for each critical position within each sentence making a total of 40 sentences (see Appendix A). At least nine words follow the last critical point in each sentence. Exploratory data by Levin and Kaplan (1968) and studies by McConkie and Rayner (1975), Rayner (1975a), and Rayner (1975b) using undergraduate students indicated that eight words past the critical point was sufficient to prevent the possibility of subjects extending their EVS to the last word in the sentence.

Each of the target sentences was placed in paragraphs of three unrelated sentences (see Appendix B). The sentences were taken from General Reading for Understanding Cards (Thurston, 1969). Sentences were taken from paragraphs 21-60, which cover a range of difficulty from seventh to ninth grade.

Since exploratory data by Levin and Kaplan (1968, p. 253) indicated that subjects scanned the first line before beginning to read aloud, the target sentence was never first in the paragraph. The target sentence was distributed among sentence positions two, three, or four in the

paragraph. The critical point occurred in either the first, second, third, or fourth word of a line. Among the sentence types, therefore, the position of the target sentence in the paragraph and the position of the critical point were varied. There were at least nine words past the critical point of each target sentence on the same line to control for position effect.

Data Collection

The paragraphs were projected onto a Caramatt II screen. The subject sat directly in front of the machine. The following instructions were read to each subject: "A paragraph will be projected onto the screen directly in front of you. The paragraph will consist of four unrelated sentences. When a slide appears on the screen, you will begin reading the paragraph orally. At some predetermined point in your oral reading, I will push a remote control button which will remove the paragraph and leave a blank screen. When this occurs, you should report as much of the rest of the material as you remember seeing beyond the last word you said. The number of correct consecutive words reported will be taken as your EVS measurement for that paragraph. The EVS is defined as the number of words that your eyes are ahead of your voice. Two practice paragraphs will be presented. The total study will consist of 40 paragraphs and, therefore, 40 EVS measures. A tape recorder will be used to record exact responses. There are no right or wrong answers. We will start with the first practice paragraph."

The examiner sat behind the subject. This prevented the subject from seeing the remote control button being pushed. The order of paragraph presentations was randomized independently for each subject. This was done using twenty lists of forty random numbers and changing the order of

slide presentations for each subject. A tape recorder was used to record exact responses.

Treatment of Data

The relative merits of the major language processing models were examined by determining if there were significant differences in the intra-sentence constraints or predictability of the sentence types used in this study. A longer EVS measurement indicates greater predictability or ease in decoding the sentence. If the transformed sentences had longer EVS measurements than the basic sentences, the chunking model would be supported because the chunking model states that transformed sentences are easier to process. If the EVS measurements for transformed sentences were shorter than the basic sentences, the deep structure model would be supported. This model states that a basic sentence is easier to process than a transformed sentence.

The study involved an analysis of the effects of the three independent variables, types of transformation, basic versus transformation, and critical point on the dependent variable, eye-voice span. The independent variable, types of transformation, involved the following four levels: THERE, passive, WH-question, and IT-inversion. The second independent variable, basic versus transformation, involved two levels, the basic sentences and the transformed sentences. The third independent variable, critical point, involved five levels, the five positions in the sentence where the EVS was systematically measured. The schematic given in Figure 1 describes the design.

The data were analyzed using a randomized block factorial design. This design provides an opportunity to examine each independent variable separately to determine its effect on the EVS. The interactions of the

[illegible]

Figure 1. Schematic of the Randomized Block Factorial Design.

independent variables can also be examined to determine the effects of the interactions on the EVS.

Hypothesis

The hypothesis tested was that there was no significant difference in the degree of predictability among the sentence types used in this study. The model for the design was the following:

$$EVS_{ijkl} = \alpha + \tau_i + \alpha_j + \beta_k + \gamma_l + \alpha\beta_{jk} + \alpha\gamma_{jl} + \beta\gamma_{kl} + \alpha\beta\gamma_{jkl} + \epsilon_{ijkl}$$

where τ = effect of subjects

α = effect of types of transformations

β = effect of basic versus transformed sentences

γ = effect of critical points

The following hypotheses were tested at the .05 level of significance:

$$H_0: \alpha_j = 0 \text{ for all } j$$

$$H_1: \alpha_j \neq 0 \text{ for some } j$$

$$H_0: \beta_k = 0 \text{ for all } k$$

$$H_1: \beta_k \neq 0 \text{ for some } k$$

$$H_0: \gamma_l = 0 \text{ for all } l$$

$$H_1: \gamma_l \neq 0 \text{ for some } l$$

$$H_0: \alpha\beta_{jk} = 0 \text{ for all } jk$$

$$H_1: \alpha\beta_{jk} \neq 0 \text{ for some } jk$$

$$H_0: \alpha\gamma_{jl} = 0 \text{ for all } jl$$

$$H_1: \alpha\gamma_{jl} \neq 0 \text{ for some } jl$$

$$H_0: \beta\gamma_{kl} = 0 \text{ for all } kl$$

$$H_1: \beta\gamma_{kl} \neq 0 \text{ for some } kl$$

$$H_0: \alpha\beta\gamma_{jkl} = 0 \text{ for all } jkl$$

$$H_1: \alpha\beta\gamma_{jkl} \neq 0 \text{ for some } jkl$$

1. There are no differences in the means of the EVS among the types of transformations.
2. There are no differences in the means of the EVS among the basic and the transformed sentences.
3. There are no differences in the means of the EVS among the critical points.
4. There is no interaction between basic versus transformed sentences and types of transformation with respect to the EVS means.
5. There is no interaction between basic versus transformed sentences and the critical point with respect to the EVS means.
6. There is no interaction between types of transformation and the critical point with respect to the EVS means.
7. There is no interaction among types of transformation, the critical point, and the basic versus transformed sentences with respect to the EVS means.

Limitations

These limitations outline the boundaries of the study:

1. The sentence types used in this study were confined to the following:
 - a) A basic sentence and its THERE transformation.
 - b) An active sentence and its passive transformation.
 - c) A basic sentence and its WH-question transformation.
 - d) A basic sentence and its IT-inversion transformation with an infinitive nominalization.
 2. The sample population was restricted to graduate students.
- Results from this study can be applied only to able readers.

CHAPTER II

REVIEW OF THE LITERATURE

Before examining the degree of predictability within sentences in an effort to understand more about the strategies involved in the reading process, a preliminary understanding of the different language processing models offered by psycholinguists is necessary.

Two major models which have been developed are diametrically opposite in their theoretical positions. One model, called the deep structure model, relates reading difficulty to the number and the complexity of the transformations in sentences. The more transformations in a sentence and the more complex the transformations, the more difficult the reading. The second model, referred to as the chunk model, claims that as a sentence becomes more complex, it becomes easier to read. A third model, offered by Levin and Kaplan (1972) centers on the use of eye-voice span to determine the extent to which readers use their knowledge of the predictability within sentences in attempting to decode and comprehend the sentence.

The theoretical positions of each of the models are reviewed in this chapter. In addition, the research which has been done in an effort to support the models is presented.

The Deep Structure Model

The processing of verbal data according to the deep structure position involves a one-to-one correspondence between a grammatical model and a psychological model. The deep structure model attempts to show

a relationship between operations used in transformational-generative grammar and operations used to do verbal processing in the mind. The major goal is to study "the psychological processes which contribute to the acquisition, production and comprehension of language" (Saporta, 1967, p. 7). According to Pearson (1974-75), the deep structure model was proposed by Mehler (1963) and Miller and McKean (1964). The model has been described by Pearson in the following way: "As the surface structure form (the way we see and hear language) approaches deep structure form (the state in which we consciously or unconsciously process and understand language in the mind), comprehension is facilitated. This facilitation occurs because the listener or reader must undergo fewer operations (transformations) in order to analyze or break down the surface structure form into deep structure" (p. 158).

Since 1960 numerous studies have been conducted in an attempt to show a one-to-one correspondence between the psychological model of the reader and the operations of transformational-generative grammar. Evans (1972-1973) found that problem readers could "raise their comprehension by reading transformationally simplified prose" (p. 271). Results from some studies have shown that sentences become more complex as more transformations are added (Gough, 1966) and as different types of transformations are added (Fodor, 1967). Faqan (1971a) did not find the same results. Sentence difficulty, according to his study, was more dependent on the difficulty of the transformation rather than on the number of transformations within a sentence. It has been found that the active verb sentences are more comprehensible and easier to process than passives, nominalizations, adjectivalizations, and negatives (Coleman and Blumenfeld, 1963; Coleman, 1964; Miller, 1962), and non-embedded sentences are easier to learn than embedded sentences (Coleman, 1965). "The transformations

which make subject-plus-predicate strings into adjectivalizations, adverbializations, and nominalizations are labeled embedding transformations" (Malmstrom & Weaver, 1973, p. 173). Appositives, ing nominalizations, and common element deletions were found to be among the more difficult transformations for children to read (Fagan, 1971b).

Additional results have shown that "verbal noun phrases, noun and relative clauses, subordinate clauses, as well as the number of modifiers embedded in any noun headword, all complicate reading comprehension" (Evans, 1972-73, p. 274). Blumenfeld and Miller (1965) concluded that "certain complex grammatical constraints and relationships which do seem to affect reading ability exist in the language. These larger relationships and processes can be described and taught in terms of transformational grammar, and the relationships and processes involved in them do result in a significant improvement in reading ability" (p. 755). A previous study by Coleman and Blumenfeld (1963) and a study by Little (1975) supported these conclusions. Results by O'Donnell (1963) do not show conclusive evidence for the teaching of linguistic structure as a means of developing reading comprehension. However, O'Donnell cautioned that the ability to recognize structural relationships could be important in reading comprehension. He concluded that there are too many distinct factors involved in the reading process to make definite conclusions about the relationship between the knowledge of linguistic structure and reading comprehension.

Coleman (1962), using cloze tests, found that a technical passage divided into short sentences was significantly more comprehensible than the same information stated in longer sentences. He found that shortening clauses improved comprehension more effectively than shortening sentences. Miller and Selfridge (1950) conducted a study which indicated that readers

found context clues more useful in the reading process as the passage increased in length.

There is evidence that relational words (prepositions, adverbs, conjunctions, and pronouns) are more dependent on the whole sentence structure than are reference words (nouns, adjectives, and verbs). The relational words appear to lose their function and identity as the sentence is fragmented (Treisman, 1965).

Stoodt (1972) and Robertson (1968) reported a significant correlation between a subject's ability to identify the relationship that conjunctions signal and his reading comprehension. The easiest conjunctions were and, how, for, and as. The most difficult were when, so, but, or, where, while, now, that, and if.

There appears to be a relationship between a student's reading comprehension and his ability to recover deep structure (Reynolds, 1974; Simons, 1970). Fagan (1971a) defines deep structure as that which "allows the learner to understand the meaning of the sentence," and surface structure as "that form of the language to which the learner is exposed" (p. 169). Simons (1970) using a cloze test found that recovering deep structure was a more important aspect of reading comprehension skill than I.Q., word knowledge, and word recognition skill. Simons suggested that more studies were needed to discover the strategies readers use in recovering deep structure. Mehler and Carey (1967) found that changes in surface structure and base structure can significantly disrupt perception. Savin and Perchonock (1965) concluded that "forms involving more transformations or more complex transformations interfered with memory because they required additional psychological processing in order to get a deep structure representation" (p. 348).

Miller and McKean (1964) found that the processing of active affirmative sentences took consistently less time than passives and negatives. Passive sentences required more time to process than negatives. When a sentence contained both a passive and a negative transformation, the sentence took about as long to process as did the sum of time required to process a passive sentence and a negative sentence separately. Miller and McKean suggested that the evidence supported the idea that subjects processed separately each transformation in a sentence. Mehler (1963) and Gough (1965) also found support for this view. Mehler found evidence that subjects "do not recall the sentence verbatim, but rather that they analyze it syntactically and encode it as a kernel sentence plus appropriate transformations" (p. 350). Gough's results (1965) indicate that syntax is related to speed of understanding. The "hearer of a complex sentence transforms that sentence into its underlying kernel and that understanding of the sentence waits upon such transformation" (p. 110).

Epstein (1967) and Tulving and Potkau (1962) reported that grammar apparently influenced memory because syntax facilitated learning. Siler (1973-1974) concluded that syntax and semantics are apparently interrelated; however, syntax appeared to have a greater effect than semantics on oral reading performance. Wang (1970) found that the presence of either syntactic or semantic structure in a string of words facilitated learning. There was a greater loss in comprehensibility, however, with the removal of semantic structure. More than a 50% loss of comprehensibility was involved when the semantic structure was removed. When the syntactic structure was removed, there was only a 35% loss in comprehensibility.

The Chunk Model

The chunk model is offered as an alternative view of verbal processing by some psycholinguists. This model claims that as a sentence becomes more complex it becomes easier to read. If the surface form of a statement is already highly synthesized, comprehension is facilitated. If, on the other hand, the surface structure is broken down somewhat (is closer to its deep structure, the ultimate underlying form of a sentence), comprehension is impeded (Pearson, 1974-75, p. 156). To get from the deep structure to the surface structure of a sentence, certain transformations on the deep structure must be performed. The number of transformations necessary to get from the deep structure to the surface structure could be considered an index of the complexity of the surface structure (Pearson, 1974-75, p. 166). Advocates of the chunk model contend that a complex surface structure is easier to read than the underlying deep structure form of the sentence. This position is diametrically opposed to that of the deep structure model.

A chunk as defined by Carver (1972-73) is "a group of words, usually longer than a word and usually shorter than a sentence length. Each chunk forms a meaningful and practical unit of connected discourse" (p. 382). According to Bransford and Franks (1971), "the hearer or reader must go through some sort of synthesizing process to cement" the units "together or else he fails to do so and never comprehends the relations" (p. 331).

Research on the chunk model and its relationship to reading has been limited. In a 1970 study by Cromer, two groups of poor readers were compared on comprehension tasks. Both the "difference" group, which appeared to read word-by-word, and the "deficit" group, which appeared to have relatively inadequate vocabulary skills as measured by scores on

the Cooperative English Test of Reading Comprehension, were given stories presented in four different modes. The modes consisted of regular sentences, single words, meaningful phrases, and fragmented word groups. Under the phrase condition, words were presented in groups based on Lefevre's (1964) criteria (cited in Cromer 1970). Most sentences were separated into two or more phrases. A comprehension test consisting of twenty questions was given to each student at the end of each mode presentation. When the material was presented in preorganized phrases, the difference group but not the deficit group was able to comprehend as well as good readers. When material was organized or grouped in a meaningful way, the comprehension scores for the difference group improved. These results appeared to indicate that the difference group did not organize the reading input in a way that best facilitated good comprehension. Cromer interpreted the results in the following way: "One source of comprehension difficulty can be attributed to a difference in the way some poor readers organize reading input" (p. 471). Carver (1968), using mature readers as subjects, examined the efficiency of chunking reading material and found that the "spatial separation of reading material into meaningful related groups did not improve the reading efficiency of the mature readers" (p. 3). A study by Carver (1970b) supported the same conclusion.

Pearson (1974-75) conducted three experiments which were designed to determine linguistic variables which might affect the way third and fourth grade children comprehend verbal data when they read. According to Pearson, most of the data can be explained by the chunk model. In one experiment, Pearson examined the preferences of children among several syntactically different ways of communicating an idea. In a second experiment Pearson studied the effects of syntactic complexity on the

comprehension of causal relations. The third experiment examined the difference between the syntactic form in which statements were read and the form in which the same statements were later recalled. The findings suggested that children were able to handle complex forms and preferred working with those forms. The more subordinated and longer sentences elicited better comprehension.

Additional evidence in favor of the chunking model was found by Bransford and Franks (1971). Adult subjects were presented with larger and smaller components of sentences. The largest components were constructed to represent the relations among four simple sentences. The smallest components consisted of the four simple sentences upon which the large components were constructed. The following are examples of the sentences used in the study:

- ones: The jelly was sweet.
 The ants ate the jelly.
- twos: The ants in the kitchen ate the jelly.
- threes: The ants ate the sweet jelly which was on the table.
- fours: The ants in the kitchen ate the sweet jelly which
 was on the table.

Larger components were rated higher on recognition scores and on confidence ratings. The confidence ratings were based on the statements by the subjects indicating whether or not they had heard certain components.

Carver and Darby (1972-73) found evidence that the "chunk" test item shows "promise as an indicator of information stored during reading" (p. 285). He compared the Chunk Reading Test to the Davis Reading Test, The Nelson Denny Reading Test, and the Tinker Speed of Reading Test. The Chunk Reading Test was found to be a valid indicator of individual differences on the following: (1) efficiency of comprehension, (2)

accuracy connected with the understanding, and (3) the rate at which the thoughts are being received. The remaining three tests measured only efficiency of comprehension validly. In an additional study, Carver (1970a) found that comprehension was measured as well on chunked items as on multiple choice test items.

Epstein (1967) showed that the introduction of chunking aids in the learning process when instructions and syntactical structure favor learning. When favorable conditions do not exist, then chunks inhibit learning.

Language Development and Reading

There have been some studies conducted in which general conclusions about language development and reading have been made. The results from these studies do not appear to support any one language processing model. Chomsky (1972), focusing on the language acquisition of children between 6 and 10, found that there is a "developmental sequence of linguistic stages through which all children pass." She concluded that "the age at which different children reach the linguistic stages varies; but the sequence of stages appears to be the same for all" (p. 2). She also found that I.Q. is positively related to linguistic development across all stages. Bormuth (1970) found the same relationship between I.Q. and linguistic development. Smith (1970) showed that the syntactic level at which a student writes influences or is influenced by the syntactic level at which he reads.

Levin and Kaplan's Model

Another language processing model has been offered by Levin and Kaplan (1970). This model attempts to show "that the amount of written material which is picked up and processed by the reader depends on the amount of predictability within messages" (p. 258). Fillenbaum, Jones, and Rappoport (1964) found evidence that "the kind of word that can

appear in a sequence of speech is predictable even if speech has been grossly mutilated" (p. 186). Using the cloze procedure and coding for correct form-class completions, the authors found evidence for a "relatively tight, redundant syntactic organization of language" (p. 186). According to Levin and Kaplan's model, "some parts of sentences are more predictable than others. The exact pattern or distribution of predictability appears to depend on the grammatical structure of the sentence" (Levin, et al., 1972, p. 31). The reader actively searches for regularities in language structure. He forms hypotheses about subsequent textual materials which either are confirmed or not confirmed. Reading is more efficient when grammatical predictability leads to the confirmation of correct hypotheses. "The more certain the reader is about what is coming next, the less closely he must sample the text. With increasing uncertainty about what is to follow, sampling must become more detailed" (Levin, et al., 1972, p. 38).

EVS - The Measurement Tool

The tool used by some researchers in measuring the effects of predictability on the reader has been the eye-voice span. By definition, the eye-voice span (EVS) is "the distance usually measured in words, that the eyes are ahead of the voice" (Gibson & Levin, 1975, p. 360).

Research has demonstrated that the size of the eye-voice span is not constant. It fluctuates to reflect differences in the predictability of sentences. Three experiments were conducted to determine the influence of different orders of approximation to the English language on EVS (Lawson, 1961; Morton, 1964a; Morton, 1964b). The construction of the different orders of approximation was done in the following way: "A second order list was one on which the subject added the next word to a

sentence of which he could see only a preceding word. A 12th order list was one in which the subject added the next word to a sentence of which he could see the preceding eleven words, and so on" (Taylor & Moray, 1960, p. 7). Results of the three experiments indicated that EVS increased as the order of approximation to English increased up to the eighth order. The reason EVS did not increase after the eighth order was attributed to the observation that the "number of words read ahead was below eight words even in the highest order of approximation" (Lawson, 1961, p. 54). The authors concluded that "the pattern of regularities in a passage affects directly the amount of material in the EVS" (Morton, 1964a, p. 353).

Other experiments have been conducted which "clearly indicate that the EVS is a flexible unit dependent partially on the regularities within sentence structure" (Rode, 1974-75, p. 138). Levin and Turner (1968) found that the EVS was longer for structured sentences than for unstructured word list material. The authors concluded that all readers must to some degree take advantage of the regularities in the material they are reading.

Levin and Kaplan (1968) conducted research which supported their theory that language is constrained by rules called grammar and that a reader actively searches for these grammatical constraints or regularities as he reads through a sentence. They based their study on findings by Clark (1965) that active and passive sentences differ in constraint. Clark reported that in passive sentences, the verb and actor are highly constrained by the subject. This is not true of active sentences. Levin and Kaplan (1968) found the EVS was greater in "the more highly constrained passive form" (p. 251). Levin and Jones (1968) did not find the same results for active and passive sentences in one of their two

experiments. The findings from the second study supported the Levin and Kaplan study. Levin and Jones stated that they could not account for the differing results.

Levin, et al. (1972) and Rode (1974-75) conducted experiments which support the findings of Levin and Turner (1963) and Levin and Kaplan (1968) that "the syntactic structure of the stimulus materials would govern the EVS" (Rode, p. 127). Levin, et al. (1972) using right and left embedded sentences were concerned with examining intra-sentence constraints to determine the extent to which these constraints are actually exploited by the reader. Using a modified cloze test designed to measure the constraints in sentences, the authors found that right embedded sentences had more constraint than left embedded sentences. In three additional experiments, Levin, et al. (1972) found that EVS was larger in the right branching, indicating "that processing is directed by the nature of the constraint within sentences" (p. 30). The right branching sentences, which had been shown to have more constraint in the constraint analysis, had longer EVS measurements.

Rode (1974-75) measured syntactic constraint in verb and noun phrases which made up two five-word clauses in each sentence. Rode found that "the unit of decoding is strongly affected by phrase type" (p. 135). Using subjects from third, fourth, and fifth grade classes, Rode showed that the type of phrase, verb or noun, has a strong effect on eye-voice span. The EVS was found to terminate at verb phrases significantly more often than at noun phrases. The data indicated that the youngest group completed more phrase units than the older two groups. The older subjects "attempted to decode a unit of meaning which was a clause rather than a phrase" (p. 137). Since the mean EVS for each group of subjects was not markedly different (2.02 words for third grade subjects to 2.51 words

for fifth grade subjects), the older subject had to read four words in order to extend to a clause boundary. Rode concluded that "the EVS is a flexible unit of decoding that children use in the reading process" (p. 137).

The preceding studies demonstrate the sensitivity of the EVS as a tool for measuring the amount of contextual constraint or predictability in a sentence.

EVS and the Unit of Decoding

Studies on EVS indicate that readers attempt to 'chunk' the words in a meaningful way. In a 1970 study by Hochberg, Levin, and Frail (cited in Levin & Kaplan, 1970), students in grades two through five were asked to read a text in which spaces between words were filled in by a constant but meaningless symbol. When compared to their performance on an untreated text, second graders showed little difference in reading either text. Fifth graders, however, were strongly affected by the interword spaces. The authors interpreted the results in this way: "The younger children were reading the text word by word, so that the lack of space did not hamper their relevant processing units. Older children, who are apparently forming units that are larger than a word, are unable to use these higher order units when important cues — interword spaces — are not available" (p. 210).

Rode (1974-75) did not agree with Hochberg, Levin, and Frail that younger students read the text word by word. Rode suggested that the use of active-passive voice sentences by the authors as a measure of young readers' ability to read to phrase boundaries may have been the reasons for the results. The younger students may not have been able to alter their EVS due to a lack of reading exposure to active-passive

voice sentences. Rode found that fifth grade subjects in her study completed more clause units than third and fourth graders, while younger subjects completed more phrase units than older subjects. The indication was that "children in the beginning stage of the reading process utilized syntax to about the same degree that older more accomplished readers were using it, presumably to guide the decoding process" (p. 138). Older students were decoding or 'chunking' a unit of meaning which was a clause "while younger students were completing a unit of meaning which was a phrase" (p. 137).

Levin and Turner (1970) reported that "fast or good readers read to phrase boundaries more often than slow or poor readers" (p. 196). Resnick (1970) found that both eye-voice span and stops at phrase boundaries increased from third grade to college. Levin and Kaplan (1968) showed evidence that "phrases act as units in the perception of sentences" (Gibson & Levin, 1975, p. 366). Levin and Jones (1968) found that the tendency to read to phrase boundaries increases as one progresses through the sentence.

Related Research

EVS has been shown to be readily affected by the difficulty of the material (Anderson, 1937; Fairbanks, 1937; Levin & Cohn, 1968; Stone, 1941). The more difficult the material, the shorter the EVS. Good readers have been shown to have longer EVS scores when compared to poor readers (Buswell, 1920; Levin & Turner, 1968; Morton, 1964a). Levin and Kaplan (1968) found that even poor readers make some use of sentence structure in their reading. Better readers were found to make more use of grammatical structure in their reading than poor readers (Resnick, 1970; Tinker, 1965).

There is contradictory evidence on whether the position within a line has an effect on EVS. Buswell (1920) found that EVS had no effect on position within a line. Levin and Turner (1966) reported that J. Q. Quantz in 1897 found the longest EVS at the beginning of a line, medium length in the middle, and the shortest at the end of the line. Fairbanks (1937) found that the length of the EVS was more dependent on the difficulty of the material than on the position within a line. Levin and Jones (1968) found that EVS was longer at the end of the sentence than at the beginning.

Levin and Wanat (1967) showed that EVS varied with changes in deep structure. EVS was found to "validly discriminate between sentences with the same surface structure but with differing deep structure" (p. 237).

Summary

The two main language processing models, the deep structure model and the chunk model, are diametrically opposite in their position. The deep structure model states that the more complex a sentence in type or in number of transformations, the more difficult the sentence is to process. The chunk model takes the position that the more complex a sentence, the easier it is to process. Levin and Kaplan's language processing model appears to come closer in position to the chunk model. Levin and Kaplan state that the reader searches for regularities in language structure. The amount of language processing which occurs is dependent on the amount of predictability or constraint in the text. Levin and Kaplan have shown that the EVS was greater in the passive sentence. Since the passive sentence is a transformation of an active sentence, the findings appear to support the chunk model. The work by Levin, et al. on right and left embedded sentences does not add support

to either the chunk or deep structure model since both sentence types involve the same type of transformation. The question of which language processing model is correct remains open to further investigation.

CHAPTER III

COLLECTION AND TREATMENT OF DATA

The discussions in Chapters I and II indicated a need to examine the degree of predictability of different types of sentences in an effort to determine which one of the language processing models offers the best explanation of the strategies involved in the reading process. The purpose of this study was to determine the degree of predictability of specific sentence types.

The Sample

The participants in this study were selected from a population which consisted of University of Florida graduate students in Reading and English. It was necessary that the subjects selected be able to read vocabulary from the Functional Reading Word List for Adults (Mitzel, 1966) and to read sentences involving embedded transformations and transformations which expand the basic sentence. These two selection criteria were testable. In order to minimize the number of subjects who would have to be screened to determine if they could successfully perform the reading tasks required, subjects were limited to graduate students. All graduate students are required to score at least 1,000 or 1,100 on the Graduate Record Exam to be admitted into one of the graduate education programs. Because the Graduate Record Exam requires advanced reading skills, successful performance on the exam, as measured by the College of

Education's minimum required scores, was used as the initial screening device. The screening device was helpful since only one subject of the total tested had to be eliminated because of an inability to perform the reading tasks successfully. The subject had difficulty reading orally because of numerous regressions and errors in word attack.

Of the 27 remaining subjects who participated in the reading tasks, seven had to be eliminated. Six of the subjects were dropped from the study because each failed to read at least one target sentence correctly making it impossible to take an EVS measure at the critical point. Either the subject skipped a word preceding the critical word or skipped the critical word itself. An additional subject was dropped because the examiner failed to blacken the screen one time when the subject read a critical word.

The Instrument

Four sentence types were chosen to compose the design. They included the following:

1. a basic sentence and its THERE transformation
2. an active sentence and its passive transformation
3. a basic sentence and its WH-question transformation
4. a basic sentence and its IT-inversion transformation with
an infinitive subject nominalization

One sentence type, the active versus the passive transformation, was selected because of the conflicting results of three studies. Levin and Kaplan, in a 1968 study using active and passive sentences, had shown that passive sentences had longer EVS measures than active sentences. Levin and Jones (1968) did not find the same results in one of their two experiments using active and passive sentences. The inclusion of active

and passive sentences in this study was done to obtain additional information on this type of transformation.

The remaining three sentence types were chosen because each of the sentences involves a process in which the subject is moved from the beginning of the sentence to a position following the verb or modal.

In addition, each of the four sentence types was chosen because of the number of transformations that are involved. The passive transformation and the THERE transformation involve one transformation. The WH-question transformation involves two transformations, and the IT-inversion transformation with an infinitive subject nominalization has three transformations. Basic sentences were written for each of these sentence transformations so that a basic sentence involving no transformations could be identified with each sentence type. As a result, it was possible to collect information on the following questions:

1. Is there a difference in the degree of predictability between each basic sentence type and its transformed sentence type?
2. Does the number of transformations within a sentence affect the degree of predictability?
3. Does the type of sentence transformation affect the degree of predictability?
4. Does the position in the sentence where the eye-voice span is measured affect the degree of predictability?

In order to control for vocabulary, words used in the sentences were limited to the Functional Reading Word List for Adults (Mitzel, 1966). In developing the Functional Word List, which consists of 5,000 words, Mitzel attempted to "identify the basic words an adult needs to

know by studying all the sources of reading material to which the general public is exposed" (p. 67). The sources included the following:

1. material issued by the U. S. Government directed toward the general public, such as pamphlets on Social Security Benefits, Workman's Compensation, Civil Defense, etc.
2. material issued by local governments on such issues as driving rules and regulations, housing, etc.
3. newspapers: front page news, feature articles and classified ads (Afro-American, News-Post, Racing Form, Midnight, Tab, Daily News)
4. Application blanks for employment, credit, insurance, mortgage, etc.
5. signs in grocery stores, hardware stores, department stores, liquor stores, restaurants, etc.
6. menus
7. the Yellow Pages of a large metropolitan telephone directory
8. comic books (Herbie, Superman)
9. general advertising literature, including that which is mailed to the home or hand distributed, billboards, newspapers and magazine ads, match book covers
10. union literature
11. religious tracts that are widely distributed
12. TV commercials
13. political campaign literature and sample ballots
14. labels on packages
15. magazines (Jet, Awake)

According to Mitzel, an adult who mastered all 5,000 words on the Functional Word List would be considered literate because the words are

"representative of what an adult would be able to understand in order to make effective decisions" (p. 69).

The eye-voice span was chosen as the measurement tool based on research which demonstrated that the EVS can measure the amount of material which is picked up and processed by the reader.

A critical point (a predetermined place where the eye-voice span was measured) was chosen for each of the sentences. Each basic sentence and its transformed sentence type contained the same number of words to control for the number of words before and after each critical point. Except for the active and passive sentences, the first critical point followed the introductory word in each sentence. The second critical point followed a verb or modal. The third critical point followed a one-word noun or adjective. The fourth and fifth critical points followed three-word phrases. Each basic sentence and its transformed sentence had the same number of words before each critical point and two four-word phrases following the last critical point. One sentence was used for each critical position within each sentence.

Each target sentence (a sentence in which an EVS measurement was taken) was embedded in a paragraph composed of three unrelated sentences to control for context clues. In order to control for vocabulary and readability, the sentences used to compose the paragraphs were limited to sentences taken from General Reading for Understanding Cards 21-60 (Thurston, 1969). These paragraphs cover a range of difficulty from seventh to ninth grade.

Because a study by Levin and Kaplan (1968, p. 253) indicated that subjects scanned the first line of a paragraph before beginning to read orally, the target sentence was never the first sentence in the paragraph. The placement of the target sentence was varied among the second, third,

and fourth positions. The position of the critical point on a line was also varied to control for position effect. After each critical point, there were at least nine words on the line. This was done to prevent the possibility of subjects extending their EVS to the last word on the line. A minimum of nine words was chosen because exploratory data by Levin and Kaplan (1968), McConkie and Rayner (1975), Rayner (1975a) and Rayner (1975b) using undergraduate subjects indicated that at least eight words was sufficient. Since graduate subjects were used in this study, at least nine words followed each critical point. This proved to be sufficient since no subject read to the end of the line during the study.

Collection of Data

Each paragraph was projected onto a Caramatt II screen which presents a rear projected image. The subject was asked to sit directly in front of the screen. The same instructions were read to each subject. The instructions were: "A paragraph will be projected onto the screen directly in front of you. The paragraph will consist of four unrelated sentences. When a slide appears on the screen, you will begin reading the paragraph orally. At some predetermined point in your oral reading, I will push a remote control button which will remove the paragraph and leave a blank screen. When this occurs, you should report as much of the rest of the material as you remember seeing beyond the last word you said. The number of correct consecutive words reported will be taken as your EVS measurement for that paragraph. The EVS is defined as the number of words that your eyes are ahead of your voice. Two practice paragraphs will be presented. The total study will consist of 40 paragraphs and therefore, 40 EVS measures. A tape recorder will be used to record exact responses. There are no right or wrong answers.

We will start with the first practice paragraph." Two practice paragraphs were presented to assist the subject in his understanding of the task.

The Caramatt II had a remote control button which allowed the examiner to sit behind the subject during the data collection. The subject, therefore, was unable to see the examiner when the remote control button was pushed. This precaution prevented the subject from observing the actions of the examiner and visually anticipating when the critical point would occur.

When the paragraph appeared on the screen, the subject began reading the paragraph orally. When the subject reached the critical point in the paragraph, the examiner pushed the remote control button and the paragraph was removed. This removal was accomplished by leaving a blank slot in the slide tray following each slide. The contrast between the letters and the background was sufficiently low to eliminate any afterimage when the paragraph was removed. The subject then reported the words he remembered seeing beyond the last word he said when the screen was blackened. The number of correct consecutive words reported was taken as his EVS measure for that sentence. A tape recorder was used to record exact responses.

To control for a learning effect because of the repeated measures design, the order of paragraph presentations was randomized independently for each subject.

Treatment of Data

The EVS scores were obtained for each subject by taking the number of correct consecutive words reported after the screen was blackened. If

a subject skipped words, the EVS score was the number of correct consecutive words reported before the skipped word or words. For example, if the words that followed a critical point were, "at the scene among the motorists" and the subject reported, "at the scene among motorists," the EVS measurement would be four. If a subject reported a word incorrectly, the EVS measurement would be the number of correct consecutive words reported before the incorrect word. For example, if the words that followed a critical point were, "is dangerous on mountain trails," and the subject reported, "is dangerous on mountainous trails," the EVS measurement would be three.

A few subjects had a zero EVS measurement on a sentence. This occurred when a subject skipped the initial word following the critical point. A zero EVS measurement occurred only three times. Each time it was with a different subject and a different sentence so there was no pattern to the zero responses.

The data were analyzed within a randomized block factorial design with repeated measures. A randomized block design was used because the design met the three conditions that are necessary according to Kirk (1968, p. 131), for the appropriate use of such a design:

1. One treatment with $K =$ two or more treatment levels. In this design, there were 40 treatment levels or 40 EVS measurements.
2. Assignment of subjects to blocks so that the variability among subjects within any block is less than the variability among the blocks. The number of subjects and observations within each block must be equal. In this design, there was one subject in each block.
3. Random assignment of treatment levels to the experimental units within each block.

The design was also a factorial one since a "factorial experiment refers to the simultaneous evaluation of two or more treatments in one experiment rather than to a distinct kind of experimental design" (Kirk, 1968, p. 171).

The statistical treatment used was an analysis of variance on the 4x2x5 randomized block factorial design. Factorial analysis of variance is the "statistical method that analyzes the independent and interactive effects of two or more independent variables on a dependent variable" (Kerlinger, 1973, p. 245). The independent effects were sentence type, basic versus transformed sentences, and critical points. The interactive effects were the interactions between the three main effects. The dependent variable was the EVS measurements.

The assumptions underlying a randomized block design model are that the population covariances between pairs of treatment levels are constant and that the population variances for each of the treatment levels are homogeneous. The hypothesis tested was that there is no significant difference in the degree of predictability among the sentence types used.

The following model was used for the design:

$$\text{EVS}_{ijkl} = \mu + \tau_i + \alpha_j + \beta_k + \gamma_l + \alpha\beta_{jk} + \alpha\gamma_{jl} + \beta\gamma_{kl} + \alpha\beta\gamma_{jkl} + \epsilon_{ijkl}$$

where τ = effect of subjects

α = affect of types of transformations

β = effect of basic versus transformed sentences

γ = effect of critical points

The hypotheses tested were:

$$\begin{aligned} H_0: \alpha_j &= 0 \text{ for all } j \\ H_1: \alpha_j &\neq 0 \text{ for some } j \end{aligned}$$

$$\begin{aligned} H_0: \beta_k &= 0 \text{ for all } k \\ H_1: \beta_k &\neq 0 \text{ for some } k \end{aligned}$$

$$\begin{aligned} H_0: \gamma_l &= 0 \text{ for all } l \\ H_1: \gamma_l &\neq 0 \text{ for some } l \end{aligned}$$

$$\begin{aligned} H_0: \alpha\beta_{jk} &= 0 \text{ for all } jk \\ H_1: \alpha\beta_{jk} &\neq 0 \text{ for some } jk \end{aligned}$$

$$\begin{aligned} H_0: \alpha\gamma_{jl} &= 0 \text{ for all } jl \\ H_1: \alpha\gamma_{jl} &\neq 0 \text{ for some } jl \end{aligned}$$

$$\begin{aligned} H_0: \beta\gamma_{kl} &= 0 \text{ for all } kl \\ H_1: \beta\gamma_{kl} &\neq 0 \text{ for some } kl \end{aligned}$$

$$\begin{aligned} H_0: \alpha\beta\gamma_{jkl} &= 0 \text{ for all } jkl \\ H_1: \alpha\beta\gamma_{jkl} &\neq 0 \text{ for some } jkl \end{aligned}$$

Before any of the hypotheses could be tested, it was necessary to test the assumptions underlying the design. Chapter IV explains the results from the tests of the assumptions and the hypotheses.

CHAPTER IV
ANALYSES OF THE DATA

This study was concerned with determining the degrees of within-sentence predictability among four sentence types. Graduate students in Reading and English read orally sentences which were developed by the investigator. Eye-voice span measures were taken at predetermined places in the sentences. The data were analyzed using a randomized block factorial design with repeated measures. The hypothesis tested was that there would be no significant difference in the intra-sentence predictability of the sentence types used.

The following questions were raised in the study:

1. Is there a difference in the degree of predictability as measured by the eye-voice span between
 - a) a basic sentence and its THERE transformation
 - b) an active sentence and its passive transformation
 - c) a basic sentence and its WH-question transformation
 - d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?
2. Does the number of transformations within a sentence affect the degree of predictability?
3. Does the type of sentence transformation affect the degree of predictability?
4. Does the position in the sentence where the eye-voice span is measured affect the degree of predictability?

Findings Related to the Assumptions

The assumptions underlying the model for a randomized block design are that the population covariances between pairs of treatment levels are constant and that the population variances for each of the treatment levels are homogeneous. To test these assumptions a test for the symmetry of the variance-covariance matrix as described by Box (1950) was done. The following hypotheses were tested:

$$H_0: \sigma^2_{jj} \text{ and } \rho^2_{jj} = 0$$

$$H_1: \sigma^2_{jj} \text{ and } \rho^2_{jj} \neq 0$$

Because the observed value of chi-square was larger than the tabled value, the null hypothesis was rejected. For a detailed explanation, see Appendix C. When the data depart from the required symmetry, a conservative F test is recommended.

Findings Related to the Hypothesis

Before an evaluation of the conservative F test could be done, the F value for each of the main effects and interactions of the randomized block factorial design had to be determined. Using the BMD08V packaged program design, an analysis of variance was done. The following hypothesis was tested: There is no significant difference in the degree of predictability among the sentence types used. The following model was used:

$$EVS_{ijkl} = \mu + \tau_i + \alpha_j + \beta_k + \gamma_l + \alpha\beta_{jk} + \alpha\gamma_{jl} + \beta\gamma_{kl} + \alpha\beta\gamma_{jkl} +$$

$$\epsilon_{ijkl}$$

where τ = effect of subjects

α = effect of types of transformations

β = effect of basic versus transformed sentences

γ = effect of critical points

The hypotheses tested at the .05 level of significance were

$$H_0: \alpha_j = 0 \text{ for all } j$$

$$H_1: \alpha_j \neq 0 \text{ for some } j$$

$$H_0: \beta_k = 0 \text{ for all } k$$

$$H_1: \beta_k \neq 0 \text{ for some } k$$

$$H_0: \gamma_l = 0 \text{ for all } l$$

$$H_1: \gamma_l \neq 0 \text{ for some } l$$

$$H_0: \alpha\beta_{jk} = 0 \text{ for all } jk$$

$$H_1: \alpha\beta_{jk} \neq 0 \text{ for some } jk$$

$$H_0: \alpha\gamma_{jl} = 0 \text{ for all } jl$$

$$H_1: \alpha\gamma_{jl} \neq 0 \text{ for some } jl$$

$$H_0: \beta\gamma_{kl} = 0 \text{ for all } kl$$

$$H_1: \beta\gamma_{kl} \neq 0 \text{ for some } kl$$

$$H_0: \alpha\beta\gamma_{jkl} = 0 \text{ for all } jkl$$

$$H_1: \alpha\beta\gamma_{jkl} \neq 0 \text{ for some } jkl$$

The cell means are reported in Table 1.

The residual was determined by pooling the sums of squares of all interaction terms that contained a subject effect. This pooled residual allowed for the control of the maximum amount of error in the design. The summary table for the randomized block factorial design is found in Table 2.

Using the conservative F test with 1 and 19 degrees of freedom, the tabled value of F for the three-way interaction $TxBxC$ was found to be 4.38. Since the F value for the three-way interaction was 7.3848184, the conservative F test was significant. If the conservative F test for treatment effects is significant, an exact test will also be significant. (Kirk, 1968, p. 143). Thus, the null hypothesis was rejected. The significant

TABLE 1

Cell Means for the Randomized Block Factorial Design

	Type of Transformation				
	THERE	Passive	WH-Question	IT-Inversion	
	5.51	4.34	4.60	5.21	
	Basic vs. Transformation				
	Basic	Transformation			
	5.15	5.18			
	Critical Point				
	1	2	3	4	5
	5.48	5.09	5.04	5.26	4.94
	Basic	Transformation			
	1	2			
THERE	5.81	5.21			
Passive	5.24	5.43			
WH-Question	5.47	4.72			
IT-Inversion	5.06	5.37			
	Critical Point				
	1	2	3	4	5
THERE	5.13	5.68	5.58	5.58	5.60
Passive	5.50	4.63	6.05	5.80	4.70
WH-Question	5.68	4.88	4.03	4.30	4.10
IT-Inversion	5.68	5.20	4.53	4.38	5.35
	Critical Point				
	1	2	3	4	5
Basic	5.31	4.95	5.24	5.65	4.58
Transformation	5.65	5.24	4.85	4.88	5.30
	THERE Transformation				
	1	2	3	4	5
Critical Point	5.65	5.95	6.55	5.80	5.10
Basic	4.60	5.40	4.60	5.35	6.10
Transformation					
	Passive Transformation				
	1	2	3	4	5
Critical Point	5.45	4.05	5.80	6.70	4.20
Basic	5.55	5.20	6.30	4.90	5.20
Transformation					
	WH-Question				
	1	2	3	4	5
Critical Point	5.80	4.90	4.20	4.10	3.35
Basic	5.55	4.85	3.85	4.50	4.85
Transformation					
	IT-Inversion				
	1	2	3	4	5
Critical Point	4.35	4.90	4.40	6.00	5.65
Basic	6.90	5.50	4.65	4.75	5.05
Transformation					

TABLE 2

Summary Table for the Randomized Block Factorial Design

Source	Sum of Squares	Degrees of Freedom	Mean Square	Conventional <u>F</u>
Type(T)	95.06	3	31.69	18.67* ^a
Basic vs. Transformation(B)	.18	1	.28	.17
Critical point (C)	3.22	4	7.24	4.27
T x B	27.45	3	9.15	5.39*
T x C	148.79	12	12.40	7.31*
B x C	58.64	4	14.66	8.64*
T x B x C	150.40	12	12.53	7.38*
Subjects	348.17	19	18.32	10.79*
Residual	1257.61	741	1.70	
Total		799		

^aAstericks indicate significant F's.

three-way interaction indicated that there are significant differences among the sentence types in the degree of predictability.

In order to determine the nature of the interaction, tests of the simple interaction effects and simple main effects were done. The hypotheses were tested at the .01 level of significance (see Table 3, 5, and 7). Tukey tests were conducted to determine where the differences were significant between the T means and the C means (see Tables 4 and 6).

The data indicated that a complex interrelationship exists among the three independent variables — types of sentence transformation, basic versus transformation, and critical point.

Findings Related to the Questions

Question One

Is there a difference in the degree of predictability as measured by the eye-voice span between

- a) a basic sentence and its THERE transformation
- b) an active sentence and its passive transformation
- c) a basic sentence and its WH-question transformation
- d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?

When the differences between the basic sentences and the transformed sentences were examined, it was found that there were no significant differences between the basic sentences and the transformed sentences in fourteen out of the twenty CT combinations.

A significant difference at the .01 level was found between the basic sentence and the transformed sentence at the combination of critical point three and the basic versus the THERE transformation (CT₃₁). At critical point three, the basic sentence had a significantly higher EVS

TABLE 3

Analysis of the Interaction of Critical Point
by Type of Transformation

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
SSCT at B_1	181.62	12	15.13	8.92* ^a
SSCT at B_2	117.58	12	9.80	5.77*
SST ^b at B_1C_1	25.94	3	8.65	5.09*
SST at B_1C_2	36.30	3	12.10	7.13*
SST at B_1C_3	76.34	3	25.45	14.99*
SST at B_1C_4	73.00	3	24.33	14.34*
SST at B_1C_5	61.45	3	20.48	12.07*
SST at B_2C_1	53.70	3	17.90	10.55*
SST at B_2C_2	4.94	3	1.65	.97
SST at B_2C_3	64.10	3	21.36	12.59*
SST at B_2C_4	7.65	3	2.55	1.50
SST at B_2C_5	18.30	3	6.10	3.60
Residual		741	1.70	

^aAstericks indicate significant F's.

^bTable 4 indicates where the differences were significant among the T means.

TABLE 4

Difference of the T's

<u>B</u>	<u>C</u>	T_3	T_1	T_2	T_4
1	1	5.80	5.65	5.45	4.35
1	2	T_1 5.95	T_3 4.90	T_4 4.90	T_2 4.05
1	3	T_1 6.55	T_2 5.80	T_4 4.40	T_3 4.20
1	4	T_2 6.70	T_4 6.0	T_1 5.8	T_3 4.1
1	5	T_4 5.65	T_1 5.10	T_2 4.20	T_3 3.35
2	1	T_4 6.90	T_2 5.55	T_3 5.55	T_1 4.6
2	3	T_2 6.30	T_4 4.65	T_1 4.60	T_3 3.85

TABLE 5

Analysis of the Interaction of Basic Versus
Transformation by Critical Point

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
SSBC at T_1	46.10	4	11.52	6.79* ^a
SSBC at T_2	56.42	4	14.10	8.31*
SSBC at T_3	22.85	4	5.71	3.37*
SSBC at T_4	83.67	4	20.92	12.32*
<hr/>				
SSC at B_1T_1	21.94	4	5.49	3.23
SSC ^b at B_1T_2	99.74	4	24.94	14.69*
SSC at B_1T_3	68.36	4	17.09	10.07*
SSC at B_1T_4	43.94	4	10.99	6.47*
SSC at B_1T_1	31.84	4	7.96	4.66*
SSC at B_2T_2	23.16	4	8.04	4.74*
SSC at B_2T_3	30.56	4	7.64	4.50*
SSC at B_1T_4	67.26	4	16.82	9.91*
Residual		741	1.70	

^aAstericks indicate significant F's.

^bTable 6 indicates where the differences were significant among the C means.

TABLE 6

Difference of the C's

<u>B</u>	<u>T</u>	<u>C₄</u>	<u>C₃</u>	<u>C₁</u>	<u>C₅</u>	<u>C₂</u>
1	2	6.70	5.80	5.45	4.20	4.05
1	3	C ₁ 5.80	C ₂ 4.90	C ₃ 4.20	C ₄ 4.10	C ₅ 3.35
1	4	C ₄ 6.00	C ₅ 5.65	C ₂ 4.90	C ₃ 4.40	C ₁ 4.35
2	1	C ₅ 6.1	C ₂ 5.40	C ₄ 5.35	C ₁ 4.60	C ₃ 4.60
2	2	C ₃ 6.3	C ₁ 5.55	C ₂ 5.20	C ₅ 5.20	C ₄ 4.90
2	3	C ₁ 5.55	C ₂ 4.85	C ₃ 4.85	C ₄ 4.50	C ₅ 3.85
2	4	6.90	5.50	5.05	4.75	4.65

TABLE 7

Analysis of the Interaction of Type of Transformation
by Basic Versus Transformation

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
SSBT at C ₁	72.22	3	24.07	14.18* ^a
SSBT at C ₂ ^b	16.57	3	5.52	1.92
SSBT at C ₃	36.39	3	12.12	7.14*
SSBT at C ₄	27.63	3	9.20	5.43*
SSBT at C ₅	8.36	3	8.36	4.92*
SSB at C ₁ T ₁	11.03	1	11.03	6.50
SSB at C ₁ T ₂	.10	1	.10	.06
SSB at C ₁ T ₃	.63	1	.63	.37
SSB at C ₁ T ₄	65.03	1	65.03	38.31*
SSB at C ₃ T ₁	38.03	1	38.03	22.40*
SSB at C ₃ T ₂	2.5	1	2.50	1.47
SSB at C ₃ T ₃	1.23	1	1.23	.72
SSB at C ₃ T ₄	.63	1	.63	.37
SSB at C ₄ T ₁	2.03	1	2.03	1.19
SSB at C ₄ T ₂	32.40	1	32.40	19.09*
SSB at C ₄ T ₃	1.60	1	1.60	.94
SSB at C ₄ T ₄	15.63	1	15.63	9.21*
SSB at C ₅ T ₁	10.00	1	10.00	5.89
SSB at C ₅ T ₂	10.00	1	10.00	5.89
SSB at C ₅ T ₃	22.5	1	22.50	13.26*
SSB at C ₅ T ₄	3.6	1	3.60	2.12
Residual				

^a Astericks indicate significant F's.

^b Since SSBT at C₂ was not significant, the following tests were conducted:

SST at C ₂	24.69	3	8.22	4.85*
SSB at C ₂	3.01	1	3.31	1.95

Difference of the T's at C₂

T ₁	T ₄	T ₃	T ₂
5.675	5.200	4.875	4.625

measurement. The EVS measurements for the basic sentence and the THERE transformation are presented in Figure 2. Examples of the two sentences follow. The asterisks indicate the significant difference in EVS between the sentences at critical point three.

Basic: Officials/were/waiting/at the scene/among the motorists
near/the old road by the huge stadium.

THERE: There/were/men/on the docks/near the machinery/for the
first time since the latest injury.

At critical points two and four, significant differences were found between the active sentence and the passive sentence types (CT_{22}) (CT_{42}). The passive sentence had a longer EVS measurement at critical point two. At critical point four, the active sentence had the longer EVS measurement. The EVS measurements for the active and passive sentences are shown in Figure 3. The following are examples of the two sentences. The asterisks indicate the significant differences in EVS between the sentences at critical points two and four.

Significantly longer
EVS

	1	2*	3	4*	5
Active:	The/security/guard/was being careless/about the locks/on the glass doors of the main building.				

Significantly longer EVS

	1	2*	3	4*	5
Passive:	The/young/manager/was being introduced/to the personnel/ from the retail division of the drug company.				

A significant difference was found between the basic sentence and the WH-question transformation at critical point five. The WH-question transformation had a longer EVS measurement at critical point five. Figure 4 shows the EVS measurements for the basic sentence and the

B_1 = Basic Sentence
 B_2 = THERE Transformation

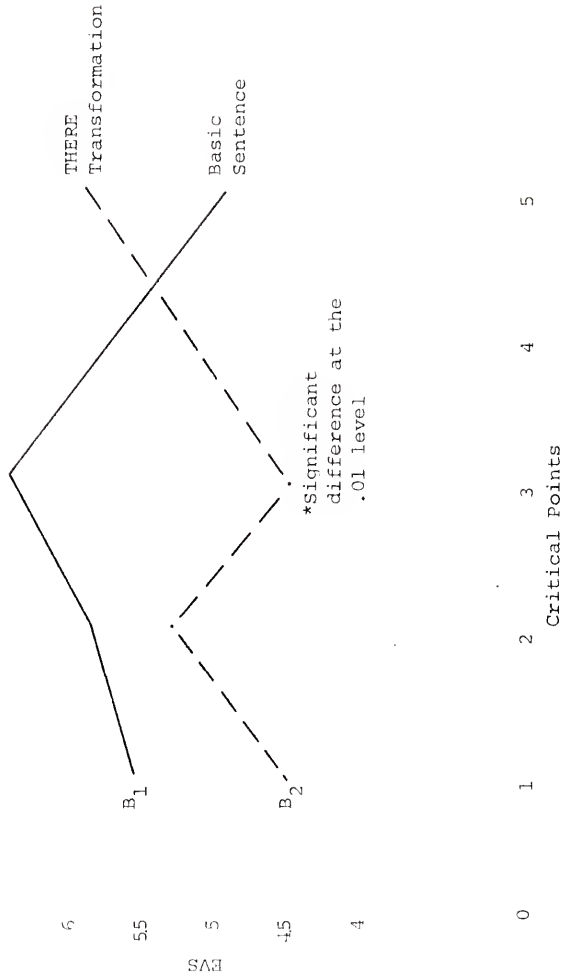


Figure 2. Mean EVS by Critical Point for the Basic and the THERE Transformed Sentences.

B_1 = Active Sentence
 B_2 = Passive Transformation

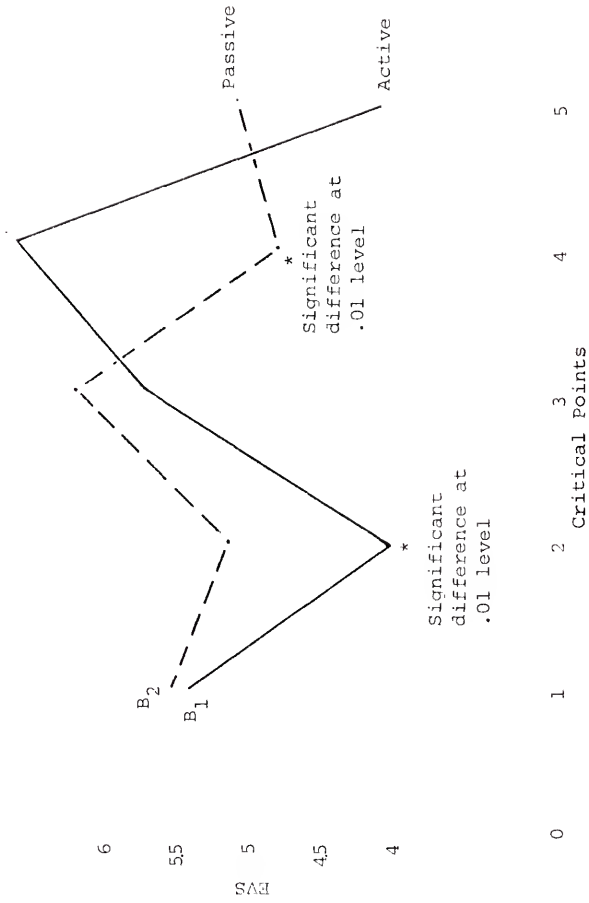


Figure 3. Mean EVS by Critical Point for the Active and Passive Sentences.

B_1 = Basic Sentence
 B_2 = WH-Question Transformation

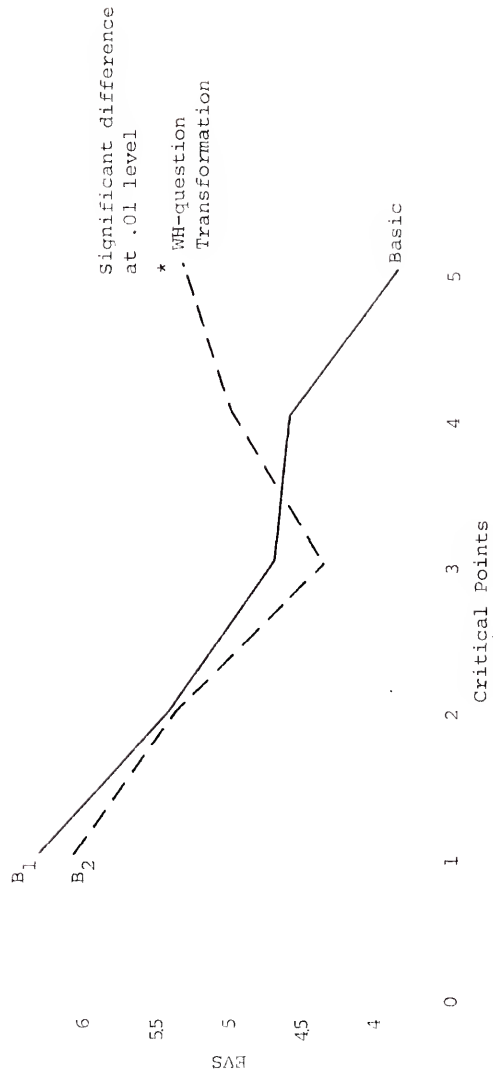


Figure 4. Mean EVS by Critical Point for the Basic and the WH-Question Transformed Sentences.

WH-question transformation. Examples of the two sentences follow. The astericks indicate the significant difference in EVS between the sentences at critical point five.

Basic: Veterans/will/usually/receive their checks/for partial
5*Significantly longer EVS
disability/within a few days after the first of the month.

WH-question: 1 2 3 4
When/will/psychologists/find an answer/for the
 5★
cause/of severe emotional problems in very young
children?

At critical point one and four significant differences were found between the basic sentence and the IT-inversion transformation with an infinitive subject nominalization. The IT-inversion transformation had a longer EVS measurement than the basic sentence at critical point one. The basic sentence had a longer EVS measurement than the IT-inversion at critical point four. The EVS measurements for the basic sentence and the IT-inversion with an infinitive subject nominalization are found in Figure 5. The following are examples of the two sentences. The astericks indicate the significant differences in EVS between the sentences at criticalpoints one and four.

Significantly longer
1 2 3 4* EVS 5
Basic: Exercise/is/difficult/in the beginning/for many individuals/
with major health problems from poor eating habits.

Significantly longer EVS

1* 2 3 4 5

IT-inversion: It/is/important/to examine lakes/in remote areas/to

identify the needs of the different fish.

B_1 = Basic Sentence
 B_2 = IT-inversion with an
 infinitive subject
 nominalization

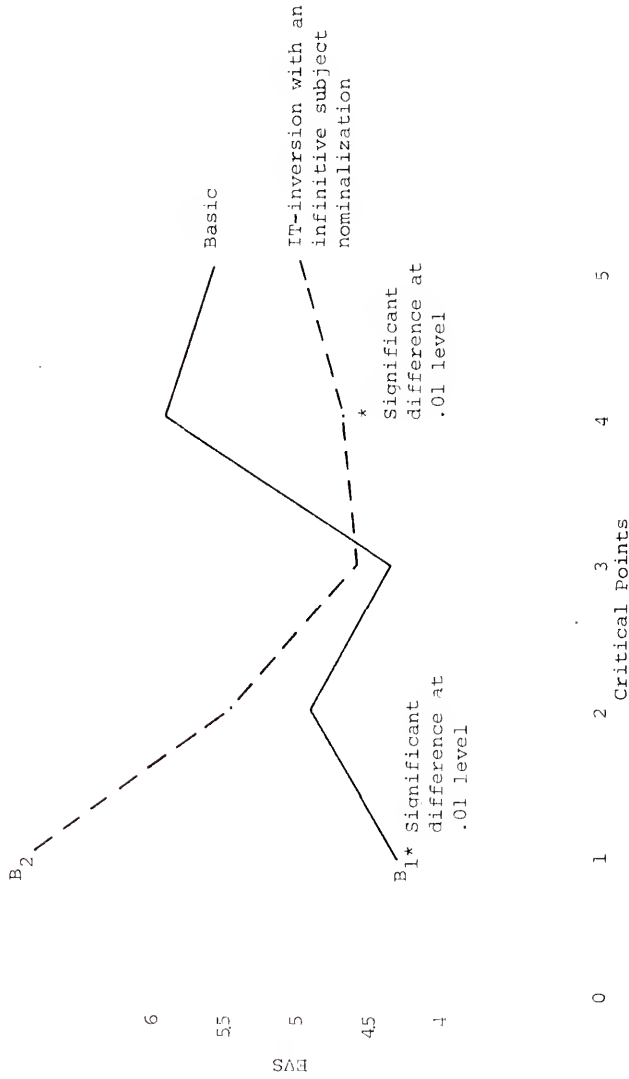


Figure 5. Mean EVS by Critical Point for the Basic and the IT-Inversion Transformed Sentences.

Question Two

Does the number of transformations within a sentence affect the degree of constraint?

When the sentence was a basic one, there were significant differences between transformation types at all the critical points. At critical point one, both the basic sentence for the WH-question transformation and the basic sentence for the THERE transformation had significantly longer EVS measurements than the basic sentence for the IT-inversion transformation. At critical point two, the basic sentence for the THERE transformation had a significantly longer EVS measurement than the basic sentence for the passive transformation. At critical point three, the basic sentence for the THERE transformation had a significantly longer EVS measurement than the basic sentence for the WH-question transformation and the IT-inversion transformation. Also, at critical point three, the basic sentence for the passive transformation had a significantly longer EVS measurement than the basic sentence for the WH-question and IT-inversion transformations.

At critical point four the basic sentence for the WH-question transformation had a significantly shorter EVS measurement than each of the other basic sentences. At critical point five, the basic sentence for the IT-inversion transformation had a significantly longer EVS measurement than the basic sentence for the WH-question and the passive transformation. Also, at critical point five, the basic sentence for the THERE transformation had a longer EVS measurement than the basic sentence for the WH-question transformation.

When the sentence was a transformed one, there were no significant differences between the transformed sentences at critical points two, four, and five. At critical point one, the IT-inversion transformation

had a significantly longer EVS measurement than each of the other three sentence transformations. At critical point three, the passive transformation had a significantly longer EVS measurement than each of the other transformed sentences.

Question Three

Does the type of sentence transformation affect the degree of predictability?

When the basic sentences were examined, it was found that at critical points one, three, four, and five there were no significant differences between the basic sentence for the THERE transformation and the basic sentence for the passive transformation. There were significant differences between the other two basic sentences, and there was no pattern evident.

When the transformed sentences were examined, it was found that at critical points one, two, four, and five there were no significant differences between the THERE transformed sentence and the passive transformed sentence (see Figure 6). Each of the sentences has one transformation. Examples of the two sentences follow. The astericks indicate the significant difference in EVS between the sentences at critical point two.

			Significantly longer EVS		
	1	2*	3	4	5
THERE:	There/	were/	men/on	the docks/near	the machinery/for
					the
					first time since the latest injury.

	1	2*	3	4	5
Passive:	The/old/	dog/was	being taken/by	his owner/to	the
					dedicated veterinarian in the old neighborhood.

B_1 = THERE Transformation
 B_2 = Passive Transformation

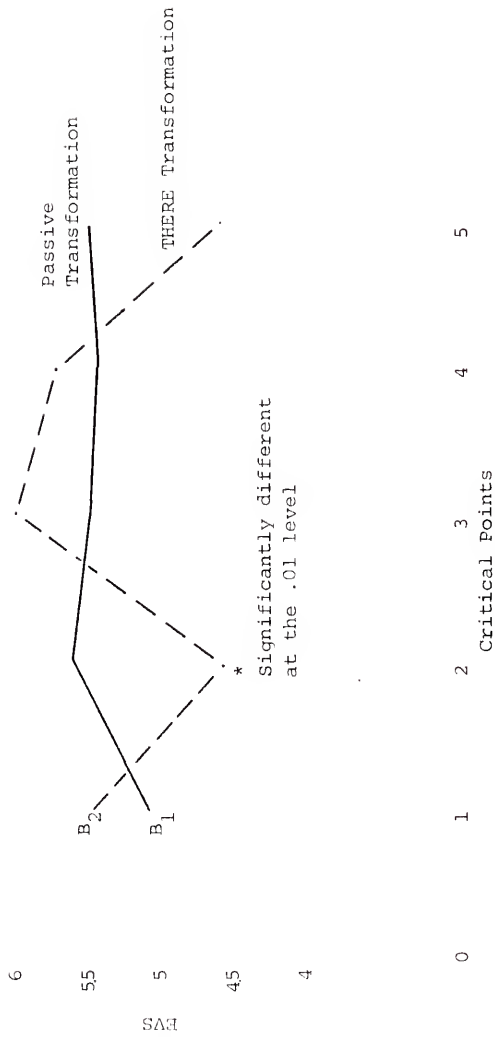


Figure 6. Mean EVS by Critical Point for Passive and THERE Transformed Sentences.

Question Four

Does the position in the sentence where the eye-voice span is measured affect the degree of predictability?

Significant differences were found between the means for the critical points at all but one of the transformation types and basic versus transformation combinations. When the sentence was a basic sentence for the THERE transformation, there were no significant differences among the critical points.

There were differences between the critical point means when the sentence was a basic sentence for the passive transformation. Critical points four, three, and one had significantly longer EVS measurements than critical points five and two. When the sentence was a basic sentence for the WH-question transformation, there were significant differences at the following critical points. Critical points one and two were significantly longer in EVS measurements than critical point five. Critical point one was also significantly longer in EVS than critical points three and four. Critical point four had a significantly longer EVS than critical point five. When the sentence was a basic sentence for the IT-inversion transformation, critical points four, five, and two were significantly longer in EVS than critical point one. Critical point four also had a significantly longer EVS than critical point three.

With the THERE transformation, critical points five and two had significantly longer EVS measurements than critical points one and three. The passive transformation showed that critical points three and one had significantly longer EVS measurements when compared with critical point four. With the WH-question transformation, critical points one, two, and five had significantly longer EVS measurements than critical point three.

The IT-inverstion transformation showed that critical point one had a significantly longer EVS measurement than critical points two, three, four, and five (see Table 6).

CHAPTER V

SUMMARY CONCLUSIONS AND IMPLICATIONS

Summary

This study examined the degree of predictability of specific sentence types. The following questions were raised:

1. Is there a difference in the degree of predictability as measured by the eye-voice span between
 - a) a basic sentence and its THERE transformation
 - b) an active sentence and its passive transformation
 - c) a basic sentence and its WH-question transformation
 - d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?
2. Does the number of transformations affect the degree of predictability?
3. Does the type of transformation affect the degree of predictability?
4. Does the position in the sentence where the EVS measurement is taken affect the degree of predictability?

The study sample consisted of 20 University of Florida Reading and English graduate students.

Sentences were developed by the researcher. The eye-voice span was used as the tool for measurement because it is sensitive to the effects of different types of predictability on the reader. EVS can also be used

to examine the amount of material which is picked up and processed by the reader.

A randomized block factorial design with repeated measures was used to test the hypothesis of no significant differences in the intra-sentence predictability of the sentence types used in this study. The data indicated a significant three-way interaction among types of transformations, basic versus transformation, and critical points. An analysis of the simple interaction effects showed significant differences for all but one of the sums of squares (see Table 7). When simple main effects were examined, twenty of the thirty-eight were significant. Fifteen Tukey tests were conducted to determine which means were significantly different.

Further analysis indicated that there was a complex interrelationship among the three independent variables — type of transformation, basic versus transformation, and critical point — on the eye-voice span measurement.

There was no evidence from the data to support any of the language processing models.

Conclusions

Related to the Hypothesis

The hypothesis was that there would be no significant differences in the degree of predictability among the sentence types used in the study. Specific sentence types were chosen, and original sentences were developed. The vocabulary and the number of words in the sentences were controlled. Any differences between the EVS measurements would indicate a difference in the ability to decode the sentence and a difference in sentence predictability.

The statistical procedure did not support the hypothesis of no significant difference. Analysis of the data indicated that the three-way interaction of transformation types, basic versus transformations, and critical points was significant. Findings from the analysis of simple interaction effects, simple main effects, and Tukey tests indicated that a complex relationship existed between the three independent variables and the eye-voice span measurements. The independent variables could not be analyzed separately to determine the effect of each on the eye-voice span measurements. The complexity of the relationship among the interaction of all three independent variables requires that the differences in the eye-voice span measurements be examined, taking all three variables into account.

The conclusion drawn from the data is that the differences in the degree of predictability between sentence types as measured by the eye-voice span are dependent on the complex interrelationship among the three independent variables — sentence transformation, basic versus transformation, and critical point.

Related to the Questions

Question one: Is there a difference in the degree of predictability as measured by EVS between

- a) a basic sentence and its *THERE* transformation?

There was no significant difference except at critical point three where the transformed sentence had a significantly longer EVS measurement, indicating greater predictability only at that point in the sentence. See Figure 2. The only conclusion which can be drawn is that at critical point three, the *THERE* transformed sentence had greater predictability or was easier to decode than the basic sentence.

Is there a difference in the degree of predictability as measured by the eye-voice span between

b) an active sentence and its passive transformation?

There were no significant differences between the two types of sentences except at critical points two and four.

				Significantly longer EVS	
	1	2*	3	4*	5
Active:	The/security/guard/was being careless/about the locks/on				
	the glass doors of the main building.				
			Significantly longer EVS		
	1	2*	3	4*	5
Passive:	The/helpless/animal/ was being cornered/by the dogs/in an				
	open field near the winter cabin.				

At critical point two the passive sentence had a significantly longer EVS measurement, whereas, at critical point four the active sentence had a significantly longer EVS measurement (see Figure 3).

The results from this study do not support the findings of Levin and Kaplan (1968). The Levin and Kaplan study was based on Clark's research (1965) which showed that the latter part of the passive sentence, the verb and the actor, is highly constrained by the first part, the subject. This, according to Clark, was not true of the corresponding parts of active sentences. Levin and Kaplan's research indicated that the EVS measurements for the active and passive sentences followed the constraints of the two sentences as indicated by Clark. The passive sentence was found to have a longer EVS than the active at the point where the active and the passive forms began to be differentially constrained.

The data from the researcher's study showed that there is a discrepancy in results between the Levin and Kaplan study and this one. In this study, at the point where the active sentence, according to Levin and

Kaplan, is suppose to have a shorter EVS, the EVS for the active sentence is significantly longer. The critical points for the active and passive sentences were chosen to correspond to the other three types of sentences used in this study; however, a comparison can be made between the active and passive sentences in this study and the Levin and Kaplan study. Examples of the Levin and Kaplan active and passive sentences and the critical points follow:

	1	2	3	4	5*	6*	
Active:	The	brash	tall/man/was/certainly/being/loud/at				
			meeting of the new group on the main campus.				
							Significantly longer
					5*	EVS	
Passive:	The	cute	chubby/boy/was/slowly/being/				
					6*	Significantly longer EVS	
			wheeled/by the maid along the narrow lane to the				
			country store.				

Examples of sentences from this researcher's study follow:

						Significantly longer
	1	2	3		4*	EVS
Active:	The/reckless/cop/was being impulsive/about the message/					5
			near the murder scene from the jealous wife.			
						Significantly longer EVS
	1	2*	3		4*	
Passive:	The/last/survivor/was being examined/by hospital					
						5
			attendants/in a temporary tent near the crash site.			

In the Levin and Kaplan sentences, at critical points five and six, the passive sentence had significantly longer EVS measurements than the active sentence. In this researcher's study at critical point four, the active sentence had a significantly longer EVS measurement than the passive. Also, this researcher found that the passive sentence had a significantly longer EVS measurement than the active sentence at critical point two. Levin and Kaplan found significant differences only at points five and six.

One aspect of the language processing model proposed by Levin and Kaplan (Levin, et al., 1972), therefore, is not supported by these findings. According to Levin and Kaplan, the EVS should reflect the differences in constraints of the two sentences. This did occur. However, instead of the passive sentence having the longer EVS, the active sentence did. A study by Levin and Jones (1968) also showed the active sentence having the longer EVS measurement. Levin and Kaplan (1968) stated that they could not account for the discrepancies between the studies.

Is there a difference in the degree of predictability as measured by EVS between

- c) a basic sentence and its WH-question transformation?

The WH-question transformation was found to have a significantly longer EVS measurement than the basic sentence at critical point five. The two sentences did not show significant differences at the other critical points (see Figure 4). The only conclusion which can be drawn is that at critical point five, the transformed sentence had greater predictability or was easier to decode than the basic sentence.

Is there a difference in the degree of predictability as measured by EVS between

- d) a basic sentence and its IT-inversion transformation with an infinitive subject nominalization?

Significant differences were found at two of the five critical points. At critical point one, the IT-inversion sentence had a longer EVS measurement, whereas, at critical point four, the basic sentence had a longer EVS measurement (see Figure 5). Therefore, at the beginning of the sentence, the transformed sentence had greater

predictability or was easier to decode. At critical point four, however, the basic sentence was easier to decode.

The conclusion drawn from the data is that except for the active-passive sentences, no general conclusions can be made. In two cases, the further into the sentence one went, the easier the basic sentence was to decode. This was true when the active and passive sentences were compared, and it was true when the basic sentence and the IT-inversion sentence were compared. In the other two cases, the opposite occurred. The transformed sentences were easier to decode further into the sentences. This was true with the basic sentence and the THERE transformation, and with the basic sentence and the WH-question transformation.

Question two: Does the number of transformations affect the degree of predictability?

The reason this question was asked was to determine if support could be found for either the deep structure model, which states that the more transformations in a sentence, the harder the sentence is to read, or the chunking model, which offers a diametrically opposite explanation. The data related to this question do not support either theory. When the EVS measurements for the THERE transformation and the passive transformation, each of which had one transformation, were compared to the WH-question transformation, which had two transformations, and the IT-inversion transformation, which had three transformations, no pattern was discernible (see Table 4). The EVS did not increase or decrease as the number of transformations increased. In fact, at critical points two, four, and five, there were no significant differences in the EVS measurement among all of the transformation types. This indicates that all of the transformed sentences at critical points two, four, and five had the same degree of predictability as measured by EVS. There was no discernible difference

between the transformed sentences at those critical points. At critical point one, the IT-inversion transformation had the longest EVS measurement when compared to the other three transformations. At critical point three, the passive sentence had the longest EVS measurement.

Because a longer EVS measurement indicates greater ease in decoding and greater predictability, the data indicate that the IT-inversion transformation with three transformations is easiest to decode at critical point one, and the passive sentence with one transformation is easiest to decode at critical point three. At the remaining critical points, the reading difficulty or predictability is the same for all four transformed sentences.

In the case of the THERE transformed sentence and the passive transformed sentence, each of which has one transformation, it can be concluded that except at critical point three, the two transformed sentences were not significantly different. This conclusion appears to support one aspect of both the deep structure and the chunking models. Both models contend that sentences with the same number of transformations have the same complexity.

Question three: Does the type of transformation affect the degree of predictability?

The data related to this question indicated that in four out of five cases, there were no significant differences between the basic sentences for the THERE transformation and the basic sentences for the passive transformation. Also, in four out of five cases there were no differences between the THERE transformed sentences and the passive transformed sentences.

An examination of the basic sentences for these two transformations showed that except at critical point two, the two basic sentences were

not significantly different in the EVS measurements. This conclusion would appear to support the statement by both the deep structure and the chunking advocates that all basic sentences have the same degree of difficulty. However, when the basic sentence for the WH-question transformation and the basic sentence for the IT-inversion transformation were examined, significant differences were found between them at critical points one, four, and five. Significant differences were found between the basic sentence for the THERE transformation and the basic sentence for the WH-question transformation at critical points three and four. Significant differences were found between the basic sentence for the THERE transformation and the basic sentence for the IT-inversion transformation at critical points one, three, and five. At critical points three and four, significant differences were found between the basic sentence for the passive transformation and the basic sentence for the WH-question transformation. At critical points three and five, significant differences were found between the basic sentence for the passive transformation and the basic sentence for the IT-inversion transformation.

The data indicate that only in the case of the basic sentence for the THERE transformation and the basic sentence for the passive transformation were the sentences alike in predictability or ease of decoding in four out of the five measurements. Because both basic sentences were written for easy transformation into a sentence with one transformation, this may account for the fact that these two basic sentences were not significantly different from each other but were significantly different from the other basic sentences. The other basic sentences were written for easy transformation into a transformed sentence with two or three transformations.

In the case of the THERE transformed sentences and the passive transformed sentences, it can be concluded that except at critical point three, the two transformed sentences were not significantly different in the EVS measurements. This conclusion appears to support both the deep structure and the chunking models. The advocates of both models contend that sentences with the same number of transformations have the same complexity.

The data with regard to the THERE and passive transformed sentences indicate that except at critical point three, the two transformed sentences were not significantly different. Because both sentences have one transformation, the findings suggest that the type of transformation does not affect the sentence difficulty as long as the number of transformations remains the same. This conclusion was not supported by the data related to the basic sentences except with regard to the basic sentences for both the THERE and passive transformations. This conclusion also does not appear to support the findings of Fagan (1971) that sentence difficulty was dependent on the difficulty of the transformation rather than the number of transformations within a sentence.

Except for the passive transformation, each of the transformed sentences involves a transformation in which the subject is moved from the beginning of the sentence to a position following the verb or modal. As the conclusions concerning the relationship between type of transformation and EVS indicate, there is no discernible relationship between any of the transformed sentences except in the case of the THERE and passive transformations.

Question four: Does the position in the sentence where the EVS measurement is taken affect the degree of predictability?

In the case of the basic sentences, the basic sentence for the WH-question transformation showed a shorter EVS measurement at critical point five of the sentence when compared with critical point one. The indication is that the sentence becomes more difficult to decode toward the end of the sentence. Just the opposite occurred with the basic sentence for the IT-inversion transformation.

The data for the transformed sentences showed that there was no significant difference between critical points one and five of the WH-question transformation. The passive transformation was significantly different between critical points one and four, but not between points one and five. The THERE transformation had a significantly shorter EVS at the beginning of the sentence than at the end, indicating that the decoding process was more difficult at the end of the sentence. The opposite was true of the IT-inversion transformation, which showed a significantly higher EVS at the beginning of the sentence as opposed to the measurement at the end of the sentence.

The conclusion indicated by the data is that the critical point has a significant effect on the EVS measurement. It does make a difference where the EVS measurement is taken. However, there is no pattern. No general statements can be made about the relationship between the critical point and the EVS measurement except to state that the critical point is a significant variable.

Recommendations

This study compared the degree of predictability among specific sentence types. The findings suggest that a complex relationship exists between the three variables — types of sentence transformations, basic versus transformations, and critical points. No one variable by itself

can explain the differences in the EVS measurements. In attempting to explain the influence these variables have on the reading process, it is necessary to determine which transformations are involved; it is necessary to determine whether the sentence is in its basic form or is in its transformed state; and it is necessary to determine where the EVS measurement is taken.

The deep structure model and the chunking model offer explanations which are too simple according to the findings of this study. Of both models, the only part which appears to be partially supported by the data is the proposal that sentences with the same number of transformations have the same degree of difficulty. It is imperative that this statement be accepted with reservation because the data on basic sentences do not support this theory. All basic sentences are supposed to have the same degree of difficulty because they do not involve any transformations. This was not found to be true except in the case of the basic sentence for the THERE transformation and the basic sentence for the passive transformation.

The deep structure model proposes that a one-to-one correspondence exists between a grammatical model and a psychological model. In order to add support to this theory, the data should have indicated that as the number of transformations increased, the EVS decreased or the sentence became harder to decode. This did not occur. At critical point five, for example, the WH-question transformation had a significantly longer EVS measurement than the basic sentence. At the other four critical points, there were no significant differences between the basic sentence with no transformations and the WH-question transformation with two transformations.

The chunking model states that as a sentence becomes more complex or has more transformations, it becomes easier to read. This theory was not supported by the data. In fact, the basic sentence for the IT-inversion transformation was significantly easier to decode at critical point four than the IT-inversion transformation. At critical points two, three, and five, there were no significant differences between the basic sentence with no transformations and the IT-inversion transformation, which has three transformations.

The findings indicate that a question about Levin and Kaplan's language processing model needs to be raised. The model states that the EVS will always reflect the grammatical constraints in a sentence by showing a longer EVS where the grammatical constraint is greater. In this study, at the point where the passive sentence was more highly constrained, according to Clark (1965), the EVS for the active sentence was significantly longer. The EVS did reflect the differences in constraint, but not in the direction suggested by the model. Levin and Jones (1968) found the same results. Levin et al. (1972), working with right and left embedded sentences, showed that the results they found supported their model. The research indicates discrepancies which will require further investigation.

Because no definite patterns could be discerned among the sentences, the concern about whether a child should be presented with a transformed sentence or a nontransformed sentence may not be the important issue. It appears that too many factors are involved to answer that question with a yes or no. The data indicated that some sentences with a number of transformations were easier to read than the basic sentence while just the opposite was true of other sentences with a number of transformations.

On the basis of this study, it appears that children need to be exposed to as many sentence types as possible to allow the students to develop versatility in reading. The theory that children should not be exposed to transformed sentences until they have mastered the basic sentences is not supported by this study.

Further research needs to be conducted on different types of transformed sentences to determine how other variables such as the knowledge of linguistic structure, the length of clauses, and the inclusion of specific types of words in a sentence (conjunctions, pronouns, prepositions, verbals) affect language processing. In addition, research needs to be conducted to examine the relationship between sentences with the same number of transformations. In this study, two sentences with one transformation each showed no significant differences in four out of the five measures. If additional research supports this finding, equating sentences with the same number of transformations may be possible.

The findings which indicated significant differences among the basic sentences remain open to further investigation. All basic sentences are defined as being equal in difficulty because basic sentences contain the same number of transformations. The data did not show this to be true. Only the two basic sentences which were written for easy transformation into a sentence with one transformation were found to have no significant differences in four of the five measures.

Additional research needs to be conducted to investigate the question of whether basic sentences can be considered equal in difficulty. The evidence here is that there is a difference between the basic sentences

used in the study except the basic sentences for the THERE and passive transformations, which were written for easy transformation into sentences with one transformation.

The EVS measurement is a measurement of the decoding process. The EVS offers an opportunity to investigate the way readers process sentences. Because no measurements on comprehension were taken in this study, additional research needs to be conducted which includes an evaluation of EVS and its relationship to comprehension. Following the EVS measurements, comprehension questions could be given to determine the interrelationship among length of EVS, comprehension, and sentence type. In conducting such a study, the influence of other variables would have to be controlled. For example, if comprehension measures were taken, the target sentences would probably need to be placed in complete paragraphs rather than in paragraphs with unrelated sentences. The unrelated sentences in this study were used to control for context clues. It would be difficult to ask questions which adequately measured comprehension when the measurement was taken on a series of unrelated sentences.

Additional areas of study could involve a study of the relationship among EVS, sentence type, and the less able reader. Focusing on Chomsky's conclusions (1972) that there is a "developmental sequence of linguistic stages through which all children pass" (p. 2), studies could be conducted with less able readers to determine which sentence types are easier to decode (have longer EVS measurements). A wide range of sentence types could be examined including those involving sentences with inverted word order.

The major conclusion from this study is that all the models offer explanations of language processing which are too basic. The chunk model and the deep structure model focus on the number of transformations in a

sentence. Instead of trying to determine whether a transformed sentence is easier or harder to read, the question should be how many factors in addition to transformations affect language processing. Levin and Kaplan's model attempts to examine other variables in addition to the number of transformations in a sentence. The position in the sentence where a measurement is taken is important in the Levin and Kaplan model. The data from this study indicated that the position in the sentence where the EVS measurement was taken had a significant effect on the results. There is a question about the Levin and Kaplan model as a result of this study. The relationship between the EVS and constraint analysis was not supported.

Research which examines the relative merits of the language processing models need to be continued. The results from this study indicate that language processing is much more complicated than the explanations offered by the major models.

APPENDIX A
SENTENCE TYPES

APPENDIX A

Sentence Types

In order to control for vocabulary, words used in the sentences were limited to the Functional Reading Word List for Adults (Mitzel, 1966). Each basic sentence and its transformed sentence type contained the same number of words to control for the number of words before and after each critical point. Two four-word phrases followed the last critical point in each sentence.

Basic

- | | 1 | 2 | 3 | 4 | 5 |
|----|---|--------------|-----------------|------------------|---|
| 1. | Supervisors/were/ | listening/to | the decision/of | their employees/ | |
| | about a strike vote for more sick days. | | | | |
| 2. | Firemen were running toward the area of the fire near the front door of the new hospital. | | | | |
| 3. | Patrolmen were waiting at the scene amont the motorists near the old road by the huge stadium. | | | | |
| 4. | Officials were standing on the field near the player with a broken arm from the first game. | | | | |
| 5. | Citizens were meeting at the school with county politicians about the financial responsibilities of the area taxpayers. | | | | |

THERE Transformations

- | | 1 | 2 | 3 | 4 | 5 |
|----|--|---------------|------------------|------------------|---|
| 1. | There/were/ | carpenters/on | the project/with | the schedule/for | |
| | the entire insulation of the old building. | | | | |

2. There were men on the docks near the machinery for the first time since the latest injury.
3. There were homeowners in the vicinity with the juveniles from the recent fight at the neighborhood pool.
4. There were witnesses near the accident from the collision of the two trailer trucks on the nearby bridge.
5. There were experts at the meeting for the public about the real dangers of heavy cigarette smoking.

Active

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. The/crude/lawyer/was being offensive/at the trial/of the senior bookkeeper of the export company.
 2. The reckless cop was being impulsive about the message near the murder scene from the jealous wife.
 3. The wise minister was being polite to the assembly of very angry people from the reform group.
 4. The security guard was being careless about the locks on the glass doors of the main building.
 5. The new superintendent was being flexible in his approach to the proposed changes in the school budget.

Passive

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. The/old/dog/was being taken/by his owner/to the dedicated veterinarian in the old neighborhood.
 2. The faithful physician was being honored by his patients in the banquet room of the Oriental restaurant.
 3. The helpless animal was being cornered by the dogs in an open field near the winter cabin.

4. The young manager was being introduced to the personnel from the retail division of the drug company.
5. The last survivor was being examined by hospital attendants in a temporary tent near the crash site.

Basic

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. Passengers/will/soon/have their tickets/for the flight/to the remote island off the southern coast.
 2. Banks will probably have severe problems in the future with soaring interest rates for new housing loans.
 3. Veterans will usually receive their checks for partial disability within a few days after the first day of the month.
 4. Applicants will probably find some installments for medical insurance below the proposed rates of the new company.
 5. Pedestrians will generally find underground tunnels at convenient locations in many urban areas with heavy traffic patterns.

WH-Question Transformation

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. When/will/newsmen/know the truth/about the proceedings/against the five men from the new company?
 2. When will firemen have the equipment for their orientation to the new system of controlled fire fighting?
 3. When will psychologists find an answer for the cause of severe emotional problems in very young children?
 4. When will consumers have sufficient knowledge about the products on most grocery shelves throughout the entire country?

5. When will people have some protection against the powers of big criminal leaders with important political friends?

Basic

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. Climbing/is/dangerous/on mountain trails/for most experts/
during severe winter storms with below freezing temperatures.
 2. Exercise is difficult in the beginning for many individuals
with major health problems from poor eating habits.
 3. Flying is unpleasant during rough weather with high winds for
the few passengers with very weak stomachs.
 4. Conservation is important for the survival of life forms on
this huge planet during the future decades.
 5. Investing is necessary in all areas of our economy for the
continued growth of our industrial society.

IT-Inversion

- | | | | | | |
|--|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
|--|---|---|---|---|---|
1. It/is/wise/to deposit money/in the bank/to insure the safety
of your emergency funds.
 2. It is necessary to vaccinate people for various diseases to
prevent the spread of many dangerous germs.
 3. It is practical to discuss problems over the telephone to
eliminate the possibility of any fist fights.
 4. It is profitable to outline chapters in a book to organize
your study of unfamiliar subject matter.
 5. It is important to examine lakes in remote areas to identify
the needs of the different fish.

APPENDIX B

PARAGRAPHS CONTAINING TARGET SENTENCES
AND UNRELATED SENTENCES

APPENDIX B

The target sentences were embedded in paragraphs of unrelated sentences to control for context clues. If the sentences were related, the subject might be able to guess words based on information given in the sentences preceding the target sentence. To control for vocabulary and readability, the unrelated sentences used to compose the paragraphs were limited to sentences taken from General Reading for Understanding Cards 21-60 (Thurston, 1969). The target sentences were distributed among sentence positions two, three, or four in the paragraphs because a study by Levin and Kaplan (1968) indicated that subjects scanned the first line before beginning to read aloud.

The underlined word is the critical point where the EVS measurement was taken. To control for guessing, the position of the critical point was varied among the first, second, third or fourth word of a line. There were at least nine words past the critical point of each target sentence on the same line to control for position effect.

The worth of the product is basically dependent upon the quality of the materials from which it is made. Quakers believe that fighting is wrong, and therefore many of them refuse to become soldiers. The audience cannot see the small silken strings with which the operator makes the marionette walk or dance about the stage. Patrolmen were waiting at the scene among the motorists near the old road by the huge stadium.

A felony is usually a crime that is punishable by death or by imprisonment in a state prison. Instead, he seeks ways to make his high standard of performance a goal for others to attempt to surpass. Banks will probably have severe problems in the future with soaring interest rates for new housing loans. To obtain successful results in fine printing, the right quality of paper is essential.

An examination of any beaver logging operation shows many felled trees that have fallen away from the water. Because of the lack of men and materials, very few roads were constructed during the war. The old dog was being taken by his owner to the dedicated veterinarian in the old neighborhood. The Romans built a vast network of roads that connected their city to the farthestmost corners of their conquered possessions.

The advertisement had spoken enthusiastically of a handsome residence set on a beautifully landscaped acre. As he came closer still, he could see how she shrank and shivered when the sea waves sprinkled her with cold salt spray. They make dollars available to foreign countries which in turn can buy more from the United States. The last survivor was being examined by hospital attendants in a temporary tent near the crash site.

Charles Goodyear tried to improve this material so that it would not be affected by temperature. This water contains dissolved minerals that harden and remain on the floor of the cave. Conservation is important for the survival of life forms on

this huge planet during the future decades. Writers of fiction have portrayed the gladiators who fought for their lives in the Roman arenas as romantic and heroic figures.

The rain pounded the windows of the cockpit so hard that the pilot could not see out. He was really quite an unusual dragon, a very lazy dragon who disliked exercise of all sorts. There were experts at the meeting for the public about the real dangers of heavy cigarette smoking. I couldn't sleep after I went to bed, for every shadow and every sound assumed a menacing form.

Equipment for outdoor living must withstand sunshine, rain, and snow. If only a couple of eggs are removed, the mother bird ignores her loss and hatches the remaining eggs. The wise minister was being polite to the assembly of very angry people from the reform group. The dawn of civilization occurred at an earlier time in Northern Africa than it did in Europe.

When she was grown, she was still so beautiful that even then no one called her anything else. Most of the advances made by mankind can be attributed to the fact that man's errors can be corrected. When will people have some protection against the powers of big criminal leaders with important political friends? The bags that are used by cotton pickers are subject to a great deal of wear.

It is seldom that one finds a leader in science who is also a leader in politics or in philosophy. Supervisors were listening to the decision of their employees about a strike vote for more

sick days. Our bodies are strengthened not by what we eat but by the food that we digest. Dick wished very much that he were his cousin Bob, who had just won the state oratorical contest.

Collectors of stamps, coins, or other objects should collect common specimens as well as unusual ones. Certain conditions of moisture, light, temperature, and so on, are required by every kind of plant or animal for life. It is necessary to vaccinate people for various diseases to prevent the spread of many dangerous germs. When he witnessed the total destruction of his home, he was glad that, at least, the building was insured.

They frequently die as a result of other diseases, particularly those that affect the respiratory tract. To this poor family, not the least of the doctor's wonderful qualities was his habit of forgetting to send a bill. The prospector searches for gold, and the scientist searches for a better understanding of nature. It is wise to deposit money in the bank to insure the safety of your emergency funds.

As soon as young seals have acquired a little strength, their mothers leave them periodically. Thus when the hens are not given sufficient drinking water their production of eggs is decreased. Exercise is difficult in the beginning for many individuals with major health problems from poor eating habits. The pitcher plant is so named because the margins of its leaves fold together to form a receptacle that retains rainwater.

Industries should be sure that any equipment that may come in contact with electric current is properly grounded. Joe hated dancing school, but each week his mother sent him anyhow. The biggest obstruction in the path of progress is not lack of money but lack of men. There were homeowners in the vicinity with the juveniles from the recent fight at the neighborhood pool.

He wanted a son, to be his companion and eventually to rule after him. This is one reason, perhaps, that during the Civil War the Confederacy had such excellent leadership. It is practical to discuss problems over the telephone to eliminate the possibility of any fist fights. At the end of the story, we find our hero rich, healthy, and beloved.

During the harvest season the men on all the farms were working from morning until sunset. When hostile Indians roamed through the land, every white settlement had a fort for the protection of the inhabitants. Citizens were meeting at the school with county politicians about the financial responsibilities of the area taxpayers. In the mornings they fly out to the country to forage in grainfields and barnyards.

What we are thinking of as past is the major transition from hand tools to machines. When will psychologists find an answer for the cause of severe emotional problems in very young children? When they are well fed, they become fat and produce a larger quantity of meat. The wider lanes become faster than the narrower lanes when the traffic becomes heavier.

The end had ceased to charm, and how could there ever again be any interest in the means? Robert's record of faithful service made all of us feel that his employer's harsh treatment was hardly justified. I never read poetry just because my friends have enjoyed it, even if I consider my friends to be discriminating in taste. Veterans will usually receive their checks for partial disability within a few days after the first day of the month.

The huge bridge that spans San Francisco Bay has the same purpose and rating as a state highway. Applicants will probably find some installments for medical insurance below the proposed rates of the new company. Man brings trouble upon himself when he disturbs the balance that nature has established. The damage appears to be caused not by freezing of the cell but by the refrigeration.

Even though he had been elected class president, he still longed to be a sports hero. People are now said to spend much more time watching television than they spend listening to the radio. When will firemen have the equipment for their orientation to the new system of controlled fire fighting? Soon after we began building the cabin, our group functioned like a well-ordered machine.

It is often possible to control an epidemic when the cause of a disease and the way in which it is spread are known. It is profitable to outline chapters in a book to organize your study of unfamiliar subject matter. Over a span of

centuries any language changes so much as to be unintelligible to any but a few scholars. People in the United States have wants that are more varied than those of native people in parts of Asia and Africa.

Some of those who farm on such a plain do not realize that their endeavors necessarily involve a risk. He thought of many reasons for their unkindness and blamed them for his misery. The great steel cities of the United States are not only workshops of the present but also laboratories of the future. The faithful physician was being honored by his patients in the banquet room of the Oriental restaurant.

Evaporation is the chief process by which the atmosphere is supplied with moisture. When will consumers have sufficient knowledge about the products on most grocery shelves throughout the entire country? It is commonly said that robbing a bird's nest of some eggs deprives the world of just so many birds. They think that a newspaper will accept any article, even though it is carelessly written.

You can sew like an expert and have almost anything you want for the cost of materials. There were men on the docks near the machinery for the first time since the latest injury. He called the natives of the island Indians, because he thought that he had reached the East Indies. In some places a deep layer of relatively loose dirt covers the underlying bedrock.

We need candles, so we first took some fat and melted it into tallow. The young manager was being introduced to the

personnel from the retail division of the drug company. It is launched by means of an elastic cord, a spring catapult, or a tow cable. The society hopes that facilities for having every schoolchild's hearing tested regularly can be made available.

In some new skyscrapers, steel and glass walls an inch thick are replacing the old-style foot thick walls. Passengers will soon have their tickets for the flight to the remote island off the southern coast. On any other morning the horse would have been standing patiently at the pasture gate, waiting to be bridled. The crews of the world-circling jet planes saw three sunrises, but they were gone less than forty-six hours.

A fish must be hooked at that moment when it bites. The new superintendent was being flexible in his approach to the proposed changes in the school budget. They choose for the location of their homes that part of a sandy bank which has the greatest degree of exposure. An epidemic is an outbreak of a disease that strikes many persons at about the same time.

The earth is part of a galaxy of stars that we call the Milky Way. It is important to examine lakes in remote areas to identify the needs of the different fish. So that the beds might continue to yield pearls, the divers were cautioned against leaving the oyster to die after robbing its shell of the pearl. Incidents of this type are occurring everywhere, every day.

Intensive safety programs in many industrial plants have greatly reduced their accident rates, for many accidents can be prevented. Pedestrians will generally find underground tunnels at convenient locations in many urban areas with heavy traffic patterns. We must learn to utilize leisure time so as to develop pleasurable hobbies and to avoid the evils of idleness. If the only defects that a tire has are a smooth tread and obvious cuts, its life can be extended by recapping.

It is a well-known fact that the pressure of air decreases before a storm and increases in fair weather. Flying is unpleasant during rough weather with high winds for the few passengers with very weak stomachs. When the teacher passed through the settlement, Bill's father said that if the teacher would stay they would build a school. The purpose of a poll is either to predict or to measure public opinion on an issue.

In the sea live some very small animals whose shells are made of lime. Climbing is dangerous on mountain trails for most experts during severe winter storms with below freezing temperatures. An increase in the federal appropriation made it possible for the project to be expanded. When you have a cold, you expose to infection all those with whom you come into contact.

The doctor has warned that under no circumstances must the patient be allowed to become excited. Firemen were running toward the area of the fire near the front door of the new

hospital. Milk contains so many different kinds of nutrients that it is almost a complete diet within itself for small children. Modern thought indicates the advisability of each child's having a room to himself.

A submarine submerges by opening valves that allow water to flow into tanks. The security guard was being careless about the locks on the glass doors of the main building. Red squirrels are far from antisocial, but they do not cooperate with one another in times of danger. Plants, like animals, must be fitted for the places and climates in which they live.

This experience warned other tribes that desired to conquer Japan that this feat would not be easy. Investing is necessary in all areas of our economy for the continued growth of our industrial society. The balloon rose because the outside air was heavier than the expanded hot air in the bag. Some crystals will grow if they are hung up in a solution that contains the material that they are made of.

Many persons buy the cheapest paint on the market and become distressed when it begins to blister, peel, or crack. The reckless cop was being impulsive about the message near the murder scene from the jealous wife. An increase in temperature is easier for them to bear than an increase in the amount of cold. The goal of efficient study is maximum learning in minimum time.

A beautiful booklet filled with colored pictures and stories of interest can be obtained free of charge. The behavior of a young child who was fighting his teacher's coat in the cloakroom had a striking similarity to voodoo. When will newsmen know the truth about the proceedings against the five men from the new company? These tablets were then baked in the sun until they became hard and durable.

Once they begin to thaw, several weeks of warm weather may be required before they are totally dissolved. Packaging of goods is important, for it is the label on the package that symbolizes the producer's integrity. This coach feels that many college football players are just too big for the competition of the professional game. There were witnesses near the accident from the collision of two trailer trucks on the nearby bridge.

Women who have pursued careers know exactly what the careers are worth. Engineers in ancient Rome invented the dome and were the first to use concrete and iron beam in construction. There were carpenters on the project with the schedule for the entire insulation of the old building. The force of gravity on any of the planets is dependent on the size of the planet.

Many organizations have found that it works well to have sandwiches and coffee handy when a committee meeting is likely to be prolonged. Magazines that can sum up the history of the week in ten minutes reading time are preferred to those that take twenty. A word is of no value to us unless we can weave it into our thinking and thereby give it life. The crude

lawyer was being offensive at the trial of the senior bookkeeper of the export company.

A tough transparent membrane covers and protects their eyeballs, but they have no eyelids. The helpless animal was being cornered by the dogs in an open field near the winter cabin. These wasps dig their burrows in sand that, during the hottest part of the day, is too hot to touch. Fat surrounds food particles and thus keeps the digestive fluid in the stomach from acting on the food.

The rapidly growing child requires more protein than does the retired businessman, whose physical growth is complete. Officials were standing on the field near the player with a broken arm from the first game. Sometimes the wind and rain destroy his home and damage his harvest. Soundproofing involves the use of special construction that will reduce the transmission of noise.

APPENDIX C

SYMMETRY OF THE VARIANCE-COVARIANCE MATRIX

APPENDIX C

A formula to test the symmetry of the variance-covariance matrix is described by Box (1950). The formula for the test is:

$$B = \frac{K(K+1)^2 (2K-3)}{6(N-1) (K-1) (K^2+K-4)}$$

$$M = (N-1) \ln \frac{/S/}{/S_{ave}/}$$

$$\chi^2 = (1-E)M$$

Where K = levels of treatment, N = levels of blocks, and /S/ and /S_{ave}/ are the determinants of the S and S_{ave} matrices.

The value of E was determined by substituting K = 40 and N = 20 into the formula. The value of E was found to be .7118126.

To find the values of /S/ and /S_{ave}/, the Statistical Analysis System computer program (SAS) was used. The reported value of the determinant of S was zero which makes the value of /S/ according to SAS's level of accuracy within .000000000000000001 of zero.

The value of the determinant of S average was reported to be 16775076859. When these values are substituted into the formula

$$M = -(n-1) \ln \frac{/S/}{/S_{ave}/}$$

the value of M turns out to be an extremely large positive number. This happens because as the value of a number approaches zero, the log of that number approaches a very large negative number. Because the value of /S/ is very close to zero, the log value becomes an extremely large netative

number. The value of M, therefore, turns out to be an extremely large positive number. If the value of M is an extremely large positive number, the value of chi-square is also an extremely large positive number because the formula is

$$\chi^2 = (1-E)M$$

The tabled value of chi-square at the .05 level of significance with 819 degrees of freedom is 886.409. Because the observed value of chi-square is larger than the tabled value, the null hypothesis was rejected.

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BIOGRAPHY

Diana Lynn Lagotic was born on August 11, 1945, in Elizabeth City, North Carolina. She attended schools in Brooklyn, New York, Argentina, Newfoundland, and Miami, Florida, and graduated salutatorian from Southwest Miami High School in 1963. During the summer before her senior year, she was an exchange student in Quito, Ecuador.

She received the Bachelor of Arts in English in the College of Arts and Sciences with a minor in psychology from the University of Florida in June of 1966. While an undergraduate, she was inducted into Alpha Lambda Delta Freshman Honor Fraternity and Phi Kappa Phi Honor Fraternity.

From September 1966 to June 1968, she was employed as an English teacher at Santa Fe High School in Alachua, Florida. During the following three years she taught English at Olive Vista Junior High in Los Angeles, California. While in Los Angeles she attended the University of California at Northridge and Pepperdine College where she completed 23 semester hours of graduate work primarily in counseling and guidance.

She returned to Santa Fe High School in 1971 and taught English for a year. In August 1972 her daughter, Kristie, was born. In August 1974 she completed a Master of Education in English from the University of Florida.

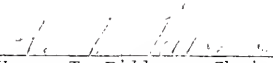
The author entered the doctoral program at the University of Florida in June 1975. During the period from April 1974 to August 1977, the

author has been employed as an English and Reading teacher at the Alachua County Adult School in Gainesville, Florida.


Memberships in professional organizations include Phi Delta Kappa, the International Reading Association, and the National Reading Conference.

The author is married to Frank Lagotic of Miami, Florida, and they have one daughter, Kristie, who is five years old.

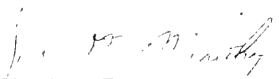
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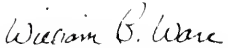
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